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OF THE

BRITISH ENCYCLOPEDIA,

OR

DICTIONARY

OF

ARTS AND SCIENCES,

COMPRISING

AN ACCURATE AND POPULAR VIEW

OF THE PRESENT

IMPROVED STATE OF HUMAN KNOWLEDGE.

BY WILLIAM NICHOLSON,

Author and Proprietor of the Philosophical Journal, and various other Chemical, Philosophical, and Mathematical Works.

ILLUSTRATED WITH

UPWARDS OF 180 ELEGANT ENGRAVINGS.

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THE

BRITISH ENCYCLOPEDIA.

S.

S, or s, the eighteenth letter, and fourteenth consonant of our alphabet; the sound of which is formed by driving the breath through a narrow passage between the palate and the tongue elevated near it, together with a motion of the lower jaw and teeth towards the upper, the lips being a little way open, with such a configuration of every part of the mouth and larynx, as renders the voice somewhat sibulous and hissing. Its sound, however, varies, being strong in some words, as *this*, *thus*, &c. and soft in words which have a final e, as *muse*, *wise*, &c. It is generally doubled at the end of words, whereby they become hard and harsh, as in *kiss*, *loss*, &c. In some words it is silent, as *isle*, *island*, *viscount*, &c. Used as a numeral, S anciently denoted seven; in the Italian music, S signifies solo; and in books of navigation, S stands for south; S. E. for south-east; S. W. for south-west; S. S. E. for south south-east; S. S. W. for south south-west, &c.

SABBATARIANS, a sect of Christians, chiefly Baptists, who observe the Jewish or Saturday Sabbath, from a persuasion that it being one of the ten commandments, which they contend are all in their nature moral, was never abrogated by the New Testament. They say that Saturday must at least be deemed of equal validity for public worship with any day never particularly set apart by Jesus Christ and his Apostles. Those of this sect, who are what are denominated Particular Baptists, hold, in common with most other Christians of the present day, all the other doctrines of grace, as they are sometimes called, *viz.* the Trinity, Atonement, Predestination, &c. &c.

In our own country, this sect is by no means numerous. They have only two congregations in London; the one of General Baptists, and the other of Particular or Calvinistic Baptists. In America, however, as we are informed by Morse, author of the American Geography, there are many Christians of this persuasion, particularly in Rhode-Island, New-Jersey, and at Ephrata, in Pennsylvania.

This tenet, frivolous and unimportant as it may appear, has contributed its quota to the *odium theologicum* of modern divinity, and has been productive of several weighty controversies. Drs. Chandler and Kennicott; Messrs. Amner, Palmer, and Estlin, in behalf of the Sunday Christians; and Mr. Cornthwaite on the side of the Sabbatarians; have all displayed their ingenuity and talents on this very important question.

SABELLA, in natural history, a genus of the Vermes Testacea class and order. Generic character: animal a nereis, with a ringent mouth, and two thicker tentacula behind the head: shell tubular, composed of particles of sand, broken shells, and vegetable substances, united to a membrane, by a glutinous cement. There are twenty-five species, of which we may notice S. scruposo; shell solitary, loose,

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simple, curved, with lentiform, glossy granulations. It inhabits India and the American Islands. The shell is subulate, obtuse at the tip, as thick as a swan's quill, and composed of equal white grains of sand. S alveolata, has nnmerous parallel tubes communicating by an aperture, forming in the mass the appearance of honey-combs. This is described by Ellis and Pennant. It is found on European coasts, covering the rocks for a considerable space, and easily breaking under the feet. The shell is composed chiefly of sand and very fine fragments of shells; the tubes straightish, two or three inches long.

SABLE. See MUSTELA.

SABLE, in heraldry, denotes the colour black, in coats of arms belonging to gentlemen; but in those of noblemen it is called diamond; and in those of sovereign princes, saturn. It is expressed in engraving by perpendicular and horizontal hatches crossing one another.

SABRE, a kind of sword, or scimitar, with a very broad and heavy blade, thick at the back, and a little falcated, or crooked towards the point. It is generally worn by the heavy cavalry and dragoons. The grenadiers, belonging to the whole of the French infantry, are likewise armed with sabres. The blade is not so long as that of a small sword, but it is nearly twice as broad. French hnzzars wear the curved one somewhat longer than those of the grenadiers. Perhaps it may be in the contemplation of his Royal Highness, the Commander in Chief, to arm the British grenadiers with this useful and formidable weapon.

SACCHARUM, in botany, *sugar cane*, a genus of the Triandria Digynia class and order. Natural order of Gramina, Gramineæ, or grasses. Essential character: calyx two-valved, involucred with a long lanugo; corolla two-valved. There are eleven species: among which we shall notice the S. officinarum, common sugar cane. The root of this plant is jointed, like that of other sorts of cane, or reed; from this root arise four, five, or more shoots, proportionable to the age or strength of the root, eight or ten feet high, according to the goodness of the ground; in very good rich soils, canes have been measured nearly twenty feet in height: these are not so much esteemed as those of a middling growth, abounding in juice, and having little of the essential salt.

The canes are jointed, more or less distant, according to the soil; a leaf is found at each joint, the base of which embraces the stalk to the next joint above its insertion, before it expands; from hence to the point it is three or four feet in length; on the under side is a deep whitish furrow, or hollowed midrib, broad and prominent; the edges are thin, and armed with small sharp teeth, which are scarcely to be discerned with the naked eye; the flowers are produced in panicles, at the top of the stalks, from two to three feet long, composed of many spikes, nine or ten inches in length; these are again subdivided into smaller spikes, having a long down enclosing the flowers, so as to hide them from sight; the seed is oblong, pointed, and ripens in the valves of the flower. It has been asserted that the sugar-cane is not indigenous of America; but that it migrated through the Europeans from Sicily and Spain, to Madeira, and the Canary Islands, afterwards to the West Indian islands, to Mexico, Peru, and Brazil.

SACCOLATES, in chemistry, salts formed from the SACLACTIC *acid*, which see.

SACERDOTAL, something belonging to priests.

SACK *of wool*, a quantity of wool containing just twenty-two stone, and every stone fourteen pounds. In Scotland, a sack is twenty-four stone, each stone containing sixteen pounds.

SACKS *of earth*, in fortification, are canvass-bags filled with earth. They are used in making entrenchments in haste, to place on parapets, or the head of the breaches, &c. to repair them, when beaten down.

SACBUT, a musical instrument, of the wind kind, being a sort of trumpet, though different from the common trumpet both in form and size: it is fit to play a bass, and is contrived to be drawn out, or shortened, according to the tone required, whether grave or acute.

SACLACTIC *acid*. To this acid Fourcroy has given the name of mucous acid, because it is obtained from gum-arabic and other mucilaginous substances. This acid may be obtained by the following process: To one part of gum-arabic, or other mucilaginous substance, add two parts of nitric acid in a retort, and apply a gentle heat. There is at first disengaged a little nitrous gas and carbonic acid gas, after which let the mixture cool. There is then precipitated a white powder which is slightly acid. This powder is the saclactic acid. Thus obtained, saclactic acid is a little gritty, and with a weak acid taste. It is readily decompos-

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ed by heat, and yields an acid liquor, which crystallizes by rest in the shape of needles It is partly sublimed in needles, or brown plates, with odour similar to that of benzoic acid Saclactic acid, in the state of powder, is not very soluble in water. Cold water does not take up more than 200 or 300 parts of its weight: boiling water does not take up above one half more. On cooling, the acid is deposited in brilliant scales, which become white in the air. The solution has an acid taste. It reddens the tincture of turnsole. Its specific gravity at the temperature of 59° is nearly the same as that of water. This acid enters into combination with earths, alkalies, and metallic oxides; and the salts which it forms are known by the name of saccolates.

SACRAMENT, signifies, in general, a sign of a thing sacred and holy; and is defined to be an outward and visible sign of a spiritual grace. Thus there are two objects in a sacrament, the one the object of the senses, and the other the object of faith. Protestants admit only of two sacraments, baptism and the eucharist, or Lord's supper; but the Roman Catholics own seven, *viz.* baptism, confirmation, the eucharist, penance, extreme unction, ordination, and marriage.

SACRIFICE, a solemn act of religious worship, which consisted in dedicating or offering up something animate or inanimate on an altar, by the hands of the priest, either as an expression of gratitude to the Deity for some signal mercy, or to acknowledge a dependence on him, or to conciliate his favour.

SACRILEGE, is church robbery, or a taking of things out of an holy place, as where a person steals any vessels, ornaments, or goods of the church.

SADDLE, is a seat upon a horse's back, contrived for the conveniency of the rider. The ancient Romans are supposed not to have made use of saddles and stirrups, and it is thought that they did not come into use till the time of Constantine the Great, A. D 340, as appears from the Greek historian Zonaras, who (through his whole history) makes no mention of a saddle for a horse, before such time as Constans, attempting to deprive his brother Constantine of the empire, made head against his army, and entering into the squadron where he himself was, cast him beside the saddle of his horse.

SAFE *conduct*, in law, is a security given by the King, under the Great Seal, to a stranger, for his safe coming into, and passing out of, the realm. Passports, however, under the King's sign manual, or licenses from his ambassadors abroad, which are now more usual, are obtained with greater facility.

SAFFRON. See Crocus.

Saffron is cultivated in fields for use, and is no where raised with so much success as in England, the English saffron being generally allowed to be greatly superior to any other. The usual way of propagating it is by the bulbs, of which it annually produces new ones. These are planted out in trenches at five inches distance, or less, and they seldom fail. They produce only leaves the first year, but in September, or October, of the year following, they flower. The saffron is gathered as soon as the flowers open, and is then separated from all filth, and formed into cakes by a very careful pressure and gentle heat. At the end of October, when the flowering season is over, the bulbs are taken out of the ground and hung up in a dry place, and in spring are put into the ground again.

It is not, however, the entire flower of the plant that produces it, but only some of its internal parts. It is met with in the shops in flat and thin cakes, into which it has been formed by pressing, and which consists of many long and narrow filaments, that are smallest in their lower part, where they are of a pale yellow colour; in their upper part they are broader and indented at their edges, and of a very strong and deep orange colour, approaching to redness. They are somewhat tough, moderately heavy, very easily cut, of an acrid, penetrating, but not unpleasant smell, somewhat affecting the head, and of a bitterish and hot, but highly cordial taste. Thrown into water, they almost instantaneously give it a strong yellow or reddish colour, according to the quantity used. The filaments are the cristated capillaments, into which the pistil of the flower divides at its head; they are of a deep reddish orange colour, while growing, and there are only three of them in each flower.

Hitherto saffron has not been subjected to a correct chemical analysis. From the experiments of Neumann, it does not appear that any volatile oil can be procured from it by distillation. It is probable, however, that it owes its strong smell to such a principle, though in too small a quantity to be easily obtained separate. The colouring matter of saffron is equally soluble in alcohol and water.

SAGAPENUM. See Gum *resin*.

SAGE. See Salvia.

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SAGINA, in botany, *pearl-wort*, a genus of the Tetrandria Tetragynia class and order. Natural order of Caryophyllei, or Caryophylleæ. Essential character: calyx four-leaved; petals four; capsule one-celled, four-valved, many-seeded. There are five species, of which the most remarkable is the sagittafolia, growing naturally in many parts of England. The root is composed of many strong fibres, which strike into the mud; the footstalks of the leaves are in length proportionable to the depth of the water in which they grow; so they are sometimes almost a yard long: they are thick and fungous; the leaves, which float upon the water, are shaped like the point of an arrow, the two ears at their base spreading wide asunder, and are very sharp pointed. There is always a bulb at the lower part of the root, growing in the solid earth beneath the mud. This bulb constitutes a considerable part of the food of the Chinese; and upon that account they cultivate it. Horses, goats, and swine, eat it; cows are not fond of it.

SAGITTA, in astronomy, the *arrow*, or *dart*, a constellation of the northern hemisphere, near the eagle, consisting of five stars, according to Ptolemy and Tycho; but in Mr. Flamstead's catalogue, of no less than twenty-three.

Sagitta, in geometry, a term used for the absciss of a curve.

Sagitta, in trigonometry, the same with the versed sine of an arch.

SAGITTARIA, in botany, *arrow-head*, a genus of the Monoecia Polyandria class and order. Natural order of Tripetaloideæ. Junci, Jussieu. Essential character: calyx three-leaved; corolla three-petalled: male, filaments commonly twenty-four: female, pistils many; seeds many, naked. There are five species.

SAGITTARIUS, the *archer*, in astronomy, the ninth sign of the zodiac. The stars in this constellation in Ptolemy's catalogue are thirty-two, in Tycho's sixteen, and in Mr. Flamstead's fifty-two.

SAGO, a simple brought from the East Indies, of considerable use in diet as a restorative.

Sago and salop are vegetable fecula. The former is the produce of the cycas circinalis, and is extracted from the pith of the stem and branches, by maceration in water; it is washed, passed through a perforated copper plate, so as to reduce it to grains, which are dried. Salop is the produce of the orchis mascula. The lately introduced arrow-root powder is said to be the produce of the maranta arundinacea. Cassava is prepared from the tuberose root of the manise (jatropha manihot). With the fecula of this root there is associated an acrid and poisonous juice, which is, however, completely separated, by washing, in the process, by which it is extracted. The roots of the bryonia alba, and the arum maculatum, are likewise composed principally of fecula, associated with acrid matter, which is separated in the process by which the fecula is extracted from them. These two were formerly prepared for medicinal use. Wheat affords, perhaps, a larger quantity of fecula than any other vegetable substance, and in a state of perfect purity. A very pure fecula, in large quantity, is also extracted from the potatoe, the root being peeled, well cleansed, and rasped, the pulp placed on a hair sieve, and water poured on it until the fecula is extracted, which, after being deposited, is washed and dried.

SAHLITE, in mineralogy, a species of the Talc genus, of a light greenish-grey colour; it occurs massive; externally it is shining and splendent; its principal fracture is foliated; fragments frequently rhomboidal; consists of very coarse granular distinct concretions: it is translucent on the edge; semihard, brittle, and easily frangible; specific gravity 3.21. It is found at Sahlberg, in Sweden.

SAICK, or Saique, a Turkish vessel, very common in the levant, for carrying of merchandize.

SAIL, in navigation, an assemblage of several breadths of canvass, sewed together by the lists, and edged round with a cord, fastened to the yards of a ship, to make it drive before the wind. Every yard in a ship has its proper sail, except the cross-jack, which takes its name from the yard: and those which are not bent to the yard, are the flying jib, fore, foretop, main, maintop, maintop-gallant, mizen, mizentop-mast stay-sails, main and maintop studding sails.

SAILING, properly denotes the art of navigating and working a ship, or of causing her to observe such motions and directions as are assigned by the navigator; in which sense sailing differs from navigation, and must be learned by practice on shipboard. See Navigation.

Sailing also denotes a particular method of navigation; in which sense we say, Mercator's sailing, plane sailing, parallel sailing, middle latitude sailing, and great circle sailing.

Sailing, *great circle*, in navigation, the art of finding what places a ship must go

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through, and what courses to steer; so that her track shall be in the arch of a great circle, or nearly so, passing through the place sailed from and that bound to. It is chiefly on account of the shortest distance that this method of sailing has been proposed; for in the sphere, it is well known that the shortest distance between two places is the arch of a great circle intercepted between them, and not in the rhumb, or spiral, passing through those places.

As, in Mercator's sailing, the several cases are solved by plain triangles; so the solution of the cases of great circle sailing is obtained by means of spherical triangles; and, therefore, the navigator should be master of spherical trigonometry, before he attempts this method. See TRIGONOMETRY.

SAILORS, the principal seamen who are employed in working or managing the sails, the tackle, steering, &c.

SAL *ammoniac, natural*, in mineralogy, a species of the fossil salts, is of a greyish white colour, passing to yellow. It is flaky, and of a saline consistence. It occurs massive, and likewise crystallized; the crystals are small, and adhere to or intersect one another; externally shining, internally splendent or shining, and lustre vitreous. The substance is composed of

Muriate of ammonia -	97.50
Sulphate of ammonia -	2.50
	100.00

When placed on burning coals it emits a peculiar odour, and is volatilized in the form of white smoke; when burned or rubbed with lime, it emits an ammoniacal smell. It is said to be the product of volcanoes, and pseudo-volcanoes, where it occurs in different forms; it is also found in the waters of different lakes in Tuscany: it is found at Vesuvius, Etna, and the Lipari Æolian islands; in France; at Mount Hecla, in Iceland; and in the vicinity of inflamed beds of coal in Scotland and England. It is also found in divers parts of Asia, and in the isle of Bourbon.

SALACIA, in botany, a genus of the Gynandria Triandria class and order. Essential character: monogynous, or one-styled; calyx five-parted; corolla five-petalled; anthers placed on the apex of the germ. There are two species, *viz.* S. chinensis, and S. cochinchinensis.

SALE *of goods*. If a man agrees for the purchase of goods, he shall pay for them, before he carries them away, unless some term of credit is expressly agreed upon.

If a man, upon the sale of goods, warrants them to be good, the law annexes to this contract a tacit warranty, that if they be not so, he shall make compensation to the purchaser; such warranty, however, must be on the sale. But if the vender knew the goods to be unsound, and has used any art to disguise them, or if, in any respect, they differ from what he represents them to be to the purchaser, he will be answerable for their goodness, though no general warranty will extend to those defects that are obvious to the senses.

If two persons come to a warehouse, and one buys, and the other, to procure him credit, promises the seller, "if he do not pay you, I will;" this is a collateral undertaking, and void, without writing, by the statutes of frauds; but if he say, "let him have the goods, I will be your paymaster;" this is an absolute undertaking as for himself, and he shall be intended to be the real buyer, and the other to act only as his servant. The question in these cases is always which party was originally trusted. For if the party to whom the goods are delivered was ever considered as responsible, the engagement of the other is void, unless it is in writing; after earnest is given, the vender cannot sell the goods to another without a default in the vender; and therefore, if the vendee does not come and pay, and take the goods, the vender ought to give him notice for that purpose; and then if he does not come and pay, and take away the goods, in convenient time, the agreement is dissolved, and he is at liberty to sell them to any other person.

SALEP, or SALOP. See SAGO.

SALIANT, in fortification, denotes projecting. There are two kinds of angles, the one saliant, which are those that present their point outwards; the other re-entering, which have their points inwards. Instances of both kinds we have in tenailles and star-works.

SALIANT, SALIENT, or SAILLANT, in heraldry, is applied to a lion, or other beast, when its fore-legs are raised in a leaping posture. A lion salient is that which is erected bend-ways, standing so as that his right fore-foot is the dexter chief point, and his hinder left foot is the sinister base point of the escutcheon, by which it is distinguished from rampant.

SALIC, or SALIQUE LAW, an ancient and fundamental law of the kingdom of France, usually supposed to have been made by Pharamond, or at least by Clo-

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vis, in virtue whereof males are only to inherit.

SALICORNIA, in botany, *jointed glasswort*, a genus of the Monandria Monogynia class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: calyx ventricose, entire; petals none; stamens one or two; seed one, covered by the calyx. There are nine species, of which the most remarkable is the S. perennis, with a shrubby branching stalk, which grows naturally in Sheppy island. They are perennial, and produce their flowers in the same manner as the former. The inhabitants near the sea-coasts, where these plants grow, cut them up toward the latter end of summer, when they are fully grown; and after having dried them in the sun, they burn them for their ashes, which are used in making of glass and soap. These herbs are by the country people called kelp, and promiscuously gathered for use.

SALISBURIA, in botany, so named in honour of Richard Anthony Salisbury, a genus of the Monoecia Polyandria class and order. Essential character: male, amentaceous; anthers incumbent, deltoid; female, solitary; calyx four-cleft; drupe with a triangular shell. There is only one species, *viz.* S. adiantifolia.

SALIVA. The saliva which is secreted by peculiar glands, and which flows into the mouth, is a clear viscid fluid, without taste or smell. It has generally a frothy appearance, being mixed with a quantity of air. Saliva has a strong attraction for oxygen, which, by trituration, it communicates to some metallic substances, as mercury, gold, and silver. When saliva is boiled in water, albumen is precipitated, and when it is slowly evaporated, muriate of soda is obtained. A vegetable gluten remains behind, which burns with the odour of prussic acid. Saliva becomes thick by the action of acids. Oxalic acid precipitates lime. Saliva is also inspissated by alcohol. It is decomposed by the alkalies; and the nitrates of lead, of mercury, and the silver, precipitate muriatic and phosphoric acids. By distillation in a retort, it froths up, affords nearly four-fifths of its quantity of water almost pure, a little carbonate of ammonia, some oil, and an acid. What remains behind consists of muriate of soda, phosphate of soda and of lime.

SALIX, in botany, *willow*, a genus of the Dioecia Diandria class and order. Natural order of Amentaceæ. Essential character: calyx ament, composed of scales: corolla none: male, nectary a melliferous gland: female, style bifid; capsule one-celled; two valved; seeds downy. There are fifty-three species; of which we may notice the following: the S. caprea, or common sallow-tree, grows to but a moderate height, having smooth, dark-green, brittle branches; oval, waved, rough leaves, indented at top, and woolly underneath. It grows abundantly in this country, but more frequently in dry than moist situations. It is of a brittle nature, and unfit for the basket makers; but will serve for poles, stakes, and to lop for firewood: and its timber is good for many purposes. The S alba, white, or silver-leaved willow, grows to a great height and considerable bulk, having smooth, pale-green shoots; long, spear-shaped, acuminated, sawed, silvery-white leaves, being downy on both sides, with glands below the serratus. This is the common white willow, which grows abundantly about towns and villages, and by the sides of rivers and brooks, &c S. fragiles, fragile or crack willow, rises to a middling stature, with brownish, very fragile or brittle branches; long, oval, lanceolate, sawed, smooth leaves, of a shining green on both sides, having dentated glandular foot-stalks. This sort in particular being exceedingly fragile, so that it easily cracks and breaks, is unfit for culture in osier-grounds. S. Babylonica, Babylonian pendulous Salix, commonly called weeping willow, grows to a largish size, having numerous, long, slender, pendulous branches, hanging down loosely all round in a curious manner; and long, narrow, spear-shaped, serrated, smooth leaves. This curious willow is a native of the East.

All the species of Salix are of the tree kind, very hardy, remarkably fast growers, and several of them attaining a considerable stature, when permitted to run up to standards. They are usually of the aquatic tribe, being generally the most abundant, and of most prosperous growth, in watery situations; they, however, will grow freely almost any where, in any common soil and exposure; but considerably the fastest and strongest in low moist land, particularly in marshy situations, by the verges of rivers, brooks, and other waters; likewise along the sides of ditches, &c. which places, often lying waste, may be employed to good advantage in plantations of willows for different purposes.

SALLY, in the military art, the issuing out of the besieged, from their town or fort, and falling upon the besiegers in

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their works, in order to cut them off, nail their cannon, hinder the progress of their approaches, destroy their works, &c.

SALMASIA, in botany, so named in memory of Claudius Salmasius, a genus of the Pentandria Trigynia class and order. Natural order of Cisti, Jussieu. Essential character: calyx five parted; corolla five petalled; style none; capsule three-celled, three-valved, many seeded. There is but one species, *viz.* S. racemosa, a native of the woods of Guiana.

SALMO, the *salmon*, in natural history, a genus of fishes of the order of Abdominales. Generic character: head smooth, compressed; tongue white and cartilaginous; teeth in the jaws and on the tongue; gill-membrane from four to twelve-rayed; body furnished at the hind part with an adipose fin. Gmelin enumerates fifty-five species, and Shaw sixty-two, of which we shall notice the following:

S. salar, or the common salmon. This abounds principally in the Northern Seas, which it quits at particular periods, to ascend rivers to a very considerable height, and deposit its spawn in them. In order to gain the favourite spots in rivers for this purpose, which are sometimes at the distance of several hundred miles from the ocean, these fishes will overcome difficulties of surprising extent, stemming the most rushing currents, and leaping with astonishing activity over various elevations. It is related, that the same individual fishes will return to the same spot for a succession of seasons; in this respect exhibiting preferences similar to those of birds in similar circumstances. The salmon is generally about two feet and three quarters long, and has been seen of the length of six, and weighing in this case seventy-four pounds. This fish is remarkable for the excellence of its flavour, and its richness, and is a welcome dish at every table. It constitutes, also, an important article of commerce. The principal fishery for salmon, in this island, is at Berwick on the Tweed. In November, they begin to ascend that river, and soon afterwards deposit their spawn with extreme care, in recesses in the sands. Here it remains till the advance of spring, when the young are completely developed, and grow with such rapidity, that, by the beginning of August, they attain to the weight of six or seven pounds, and occasionally even more. Some hundreds have been occasionally taken in a single draught; but the average number is not above fifty. These fishes, in their most abundant season, are salted and barrelled for exportation. The principal part of these, taken before April, is sent to the London market, in a fresh state, and packed in ice. In July, the most plentiful month in the year, salmon have been sold at Berwick at the rate of less than a halfpenny per pound. The rent of the forty principal salmon-fisheries on the Tweed, between its mouth and fourteen miles upwards, towards its source, amounted, many years since, to between five and six thousand pounds per annum, and the number of fishes annually taken by these is calculated at upwards of two hundred thousand. It is a singular circumstance, that no food, if we may believe the uniform statements of fishermen, is ever found in the stomach of the salmon; yet fishes and worms are employed by the angler with success in taking them. The case may possibly be, that at particular seasons, they may totally neglect food, as is the case with some other species of animals, particularly seals, which abstain for a series of months, and this instance of exception may have been exaggerated into a universal practice.

S. fario, or common trout, is found in almost all the European streams, at least such as are cool and clear. Its length, in general, is about fourteen inches. Occasionally, it has been known to weigh ten pounds. Trout of the common size, however, are far preferable to those of such extraordinary magnitude. These fishes subsist on worms, small fishes, shell-fish, and water insects. They are extremely rapacious and devouring, and not unfrequently prey upon each other. Those are most esteemed which are found in the coldest streams, and they are generally regarded as an elegant and luxurious article of food. They appear to have been only slightly known to the Greeks and Romans, and to have been rather admired for the beauty of their appearance, than eagerly sought after for the table.

S. salvelinus, or red charr, is about a foot long, very similar in form to the common salmon, but more slender. It abounds in the rivers of Siberia, and the lakes of Germany, and in this country, in the lakes of Cumberland and Westmoreland. It is considered as one of the highest delicacies, and has the

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most brilliant colours, and finest flavour, when inhabiting the coldest waters.

The S. eperlanus, or smelt, is about seven inches long, highly elegant, of a tapering form, and semi-transparent appearance. It has an odour not unlike that proceeding from vegetables, and which has by some been resembled to that of a violet, and by others to that of a cucumber. In the winter months it is caught in extreme abundance in the rivers Thames and Dee.

The S. Greenlandicus, or Greenland salmon. These abound off the coast of Greenland, where there are taken in vast quantities, and dried, not only for the use of man, but of cattle, for which they constitute a valuable food in winter. It is about the size of a smelt.

S thymallis, or the grayling, is about a foot and a half long, and abounds in the rivers of mountainous countries in Europe and Asia. It resembles the trout in form. In some of the rivers of England it is found in great perfection. It feeds on insects and fishes, and is highly voracious, catches with extreme avidity at the bait, and swims with extraordinary rapidity, passing through the water like a dart, or a meteor through the air.

SALON, or Saloon, in architecture, a very lofty spacious hall, vaulted at top, and sometimes comprehending two stories or ranges of windows. The salon is a grand room, in the middle of a building, or at the head of a gallery, &c. Its faces or sides ought all to have a symmetry with each other; and as it usually takes up the height of two stories, its ceiling should be with a moderate sweep. Salons are frequently built square, and sometimes octagonal.

SALPA, in natural history, a genus of the Vermes Mollusca class and order: body loose, nayant, gelatinous, tubular, and open at each extremity: intestine placed obliquely: eleven species have been enumerated, in two divisions; A. furnished with an appendage: B. without the terminal appendage. The animals of this genus are of a gregarious nature, and often adhere together: they swim with great facility, and have the power of contracting or opening at pleasure the cavities at the extremities.

SALSOLA, in botany, *salt-wort*, a genus of the Pentandria Digynia class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: calyx five-leaved; corolla none; capsule one-seeded; seed screw-shaped. There are thirty-one species. These plants are well known for producing alkaline salt, commonly called barilla, soda, or kelp; many of them are herbaceous and annual, some have shrubby stems. The leaves are generally alternate, in some opposite, others round or flat; flowers terminating or axillary. S. kali grows naturally in the salt marshes in divers parts of England. It is an annual plant, which rises above five or six inches high, sending out many side branches, which spread on every side, with short awl-shaped leaves, which are fleshy, and terminate in acute spines. S. soda rises with herbaceous stalks near three feet high, spreading wide. The leaves on the principal stalk, and those on the lower part of the branches, are long, slender, and have no spines: those on the upper part of the stalk and branches are slender, short, and crooked. All the sorts of glass-wort are sometimes promiscuously used for making soda or mineral alkali, but this species is esteemed best. The manner of making it as follows: having dug a trench near the sea, they place laths across it, on which they lay the herbs in heaps, and having made a fire below, the liquor which runs out of the herbs drops to the bottom, which at length thickening, becomes soda, which is partly of a black, and partly of an ash-colour, very sharp and corrosive, and of a saltish taste. This, when thoroughly hardened, becomes like a stone, and in that state is transported to different countries for the making of glass, soap, &c.

SALT, *culinary*, or Muriate of Soda. This salt is one of the most abundant productions of nature, and exists native in much greater quantity than any other neutral salt. The waters of the ocean owe their saltness to it: it is found in a number of mineral springs, and it forms immense strata in the bowels of the earth, or rising on the surface, even to the height of mountains. According as it is produced from these sources, it is named sea-salt, or rock-salt. Rock-salt is solid, hard, and more or less transparent, of a white, grey, or reddish colour, sometimes of a bright or deep red, or yellow, and more rarely with spots of blue. Its fracture is foliated or fibrous; generally it is massive, but sometimes crystallized in cubes, and its fragments are always of a cubical form. The colours have been supposed to depend on the oxide or muriate of iron. In general it is pure, and hence its taste is purely saline; but sometimes it is bitter from the presence of foreign salts. There are immense mines

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of it in different countries. Those of Cracow, in Gallicia, have been long celebrated. It abounds in the east and south of Germany, is found in large quantities in Spain, and likewise in Cheshire, in England. In Africa, Asia, and America, it is not less extensively distributed, forming hills above the surface, or very extensive beds. It is always connected with rocks of secondary formation, and generally with gypsum or sulphate of lime.

Dr. Watson, in the second volume of his "Essays," speaking of the salt mines, says, "There are several mines of rock-salt near Northwich, in Cheshire, the first of which was discovered as they were boring for coal in the year 1670. The springs which are met with, both above and below the level of the Northwich bed of rock-salt, are strongly impregnated with salt. This is easily accounted for: the rain-water, in sinking through the ground which lies over the rock-salt, at last arrives at the salt; its further descent is in a great measure obstructed by the solid body of salt; it rests upon it, and in resting upon it dissolves it, and thus constitutes a brine-spring above the level of the bed of rock-salt. The brine-springs, which are found below that level, probably arise from the water which has dissolved a portion of rock-salt, in sinking to that depth in the earth. I have," continues the Doctor, "had the curiosity to go to the bottom of some of the most famous mines in England, but I never thought my labour in these subterraneous expeditions so well rewarded, as in the sight of the rock-salt mines at Northwich. These are superior to the mines at Cracow, in Poland, which have, for many centuries, been the subject of general admiration." A single pit, at Northwich, yields, at a medium, 4,000 tons of salt in a year.

In different countries, the process of obtaining salt is different. In very cold climates, the water, being received into shallow ditches during the winter, is frozen, by which a great part of the superfluous water is removed, and the remaining liquor affords salt, by artificial evaporation. In warm climates it is obtained by spontaneous evaporation. The water is received into broad, shallow trenches at the sea side, without the reach of the tide. The bottom of these is made of clay, well beaten, and they are divided into several departments. The fluid being thus spread out on an extensive surface, quickly evaporates, and by sluices it is removed from one department to another, so that when it arrives at the last, it is a strong brine, and the salt is soon deposited. It is necessarily mixed with the clay of the ground, and with several of the neutral salts, and other impurities, which sea-water contains. Salt, prepared in this manner, is known by the name of bay-salt. In colder climates, recourse must be had to artificial evaporation. The water is heated in shallow iron pans. Muriate of soda possesses the singular property, that it is as soluble in cold as in hot water; after due evaporation, therefore, it begins to crystallize on the surface of the hot liquor; the crystals, as they increase, fall to the bottom of the vessel, are raked out, and set to drain. This is the process by which it is obtained in this country. Sometimes this method is conjoined with natural evaporation. The sea-water, before it is received into the boiler, is pumped into a large reservoir, under which faggots of thorns &c. are suspended It is allowed to drop over these, and a large surface being thus presented to the atmosphere, while the air is also rapidly renewed, a considerable part of the water is evaporated. It is then conveyed to the boiler, and evaporated in the usual manner. Or, in some of the northern departments of France, the sea-water is made to flow over a bottom of clay covered with sand, which favours both the evaporation of the water and the concretion of the salt; the saline deposit, which is at length formed, is lixiviated with sea-water, which, becoming thus more impregnated with salt, is concentrated by boiling, so as to afford it by hasty crystallization. Sea-salt, obtained by any of these processes, is never perfectly pure. Sea-water, by its analysis, is found to contain, besides muriate of soda, several other neutral salts, particularly muriate of magnesia, muriate of lime, and sulphate of soda. These, being much more soluble in hot than in cold water, remain dissolved in the hot liquor from which the salt crystallizes. A small quantity of them, however, still adheres to the muriate of soda; they render it deliquescent, give it a bitter taste, and considerably impair its antiseptic power. Different processes have therefore been contrived to obtain the salt free from these mixtures. The most simple is, merely to procure the salt by a slow artificial evaporation. It then crystallizes with scarcely any mixture of the others. This is the cause of the superior purity of the bay-salt. Hence, also, the larger the crystals

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of sea-salt are, they may be justly supposed to be the purer, as the largeness of the crystals is owing to the slowness of the evaporation by which they are formed.

For chemical purposes, muriate of soda is most easily purified by dissolving it in water, and adding to its solution a solution of carbonate of soda, drop by drop, till no cloudiness is produced by the addition. Every foreign salt is thus decomposed and precipitated, and the strained solution will contain the pure muriate of soda, which may be crystallized. Muriate of soda has a salt, rather agreeable, taste, being, when pure, free from all bitterness; it is soluble in rather less than three parts of water, at the temperature of 60°. The crystals neither deliquesce nor effloresce, on exposure to the air; the common sea-salt, indeed, is deliquescent; but this is owing to the muriates of magnesia and lime which adhere to it. Exposed to heat, the crystals of muriate of soda decrepitate, from the sudden conversion of their water of crystallization into vapour. If the temperature is raised to a red heat, the salt melts; in an intense heat, it is volatilized in white vapours, without having undergone any decomposition.

Crystallized muriate of soda contains 53 of soda, and 47 of acid, containing, however, some water of composition, so that of real acid the quantity is 38.83. Its specific gravity is 2.12. This salt is decomposed by the sulphuric and nitric acids, in the same manner as the muriate of potash is. It is from its decomposition by the sulphuric acid, that the muriatic acid is best obtained; as has already been observed. When decomposed by the nitric acid, part of the latter is decomposed, a quantity of its oxygen being transferred to the muriatic. One of the most important practical problems in chemistry is, to decompose this salt so as to obtain its alkali. It abounds so much in nature, that if such a process, capable of being carried on to advantage, could be discovered, a vast supply of soda would be obtained; and as this alkali can be employed for every purpose that potash can, and is even much superior to it for some uses, such a discovery would be of much importance to the chemical arts. Salt is decomposed in the usual mode by sulphuric acid; and to defray the expense, the muriatic acid is collected and employed in the manufacture of sal ammoniac, in the preparation of oxymuriatic acid for bleaching, or for any other useful purpose to which it can be applied. The sulphate of soda is calcined in a reverberatory furnace, to free it from any superfluous acid. It is then to be decomposed. It is of very extensive use. Its application to preserve animal substances from putrefaction is well known; the theory of its antiseptic quality has never yet been properly explained. It is also taken universally as a seasoning to food, and seems to be very necessary to promote digestion, as even the lower animals, it has been proved, languish, when altogether deprived of it. It is employed in a variety of arts. In the manufacture of pottery of the coarser kind, when it is thrown into the oven in which the ware is baked, it is converted into vapour, and, being applied in this state to the surface of the vessels, glazes them, an effect probably owing to the combination of its alkali with the silicious earth of the pottery. It is employed in the manufacture of glass, which it is said to render whiter and clearer; in that of soap, which it makes harder; as a flux, in the melting of metals from their ores; and in a variety of chemical and pharmaceutical processes.

Salt, in a chemical sense, is a crystallizable substance, considerably soluble in water, and highly sapid. The term is applied likewise by modern chemists to all the crystallizable acids or alkalies, or earths, or combinations of acids with alkalies, earths, or metallic oxides: hence salts in chemistry are distinguished into alkaline, earthy, and metallic, and they take their names from the acid, and alkali, &c. of which they are combined: thus the *sulphate* of soda is a combination of *sulphuric* acid and soda; the *sulphite* of soda is a combination of *sulphurous* acid and soda. The termination *ate* denotes that the salt is formed of the acid containing the greater quantity of oxygen; and the termination *ite* of the acid containing the smaller quantity of oxygen. There are also salts of triple combinations, as alum, tartarized antimony, &c. Salts are either also neutral, that is, where the ingredients are in perfect saturation, (See Neutralization,) or with the acid in excess, of which tartar is an example, or with an excess of the base, as in borax. These circumstances have been distinguished by the prefix *super* in the first case, and *sub* in the latter: hence tartar is named the super-tartrite of potash; and borax, the sub-borate of soda.

SALVADORA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Atriplices, Jussieu. Essential character: calyx four-

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cleft; corolla four-cleft; berry one-seeded; seed covered with an aril. There are three species found in China.

SALVAGE *money*, a reward allowed by the civil and statute law, for the saving of ships or goods from the danger of the seas, pirates, or enemies. Where any ship is in danger of being stranded, or driven on shore, justices of the peace are to command the constables to assemble as many persons as are necessary to preserve it; and on its being preserved by their means, the persons assisting therein shall, in thirty days after, be paid a reasonable reward for the salvage, otherwise the ship or goods shall remain in the custody of the officers of the customs, as a security for the same.

SALVIA, in botany, *sage*, a genus of the Diandria Monogynia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: corolla unequal; filaments fastened transversely to a pedicle. There are seventy-nine species. This extensive genus consists of herbs or under shrubs; the flowers are from one to three together, from a bracte, or a leaf, frequently in spikes. S. officinalis, or common large sage, which is cultivated in gardens, of which there are the following varieties: 1. The common green sage. 2. The wormwood sage. 3. The green sage with a variegated leaf. 4. The red sage. 5. The red sage with a variegated leaf These are accidental variations, and therefore are not enumerated as species. The common sage grows naturally in the southern parts of Europe, but is here cultivated in gardens for use: but the variety with red or blackish leaves is the most common in the British gardens: and the wormwood sage is in greater plenty here than the common green-leaved sage, which is but in few gardens. S. auriculata, common sage of virtue, which is also well known in the gardens and markets. The leaves of this are narrower than those of the common sort; they are hoary, and some of them are indented on their edges towards the base, which indentures have the appearance of ears.

SALVINIA, in botany, a genus of the Cryptogamia Miscellaneæ class and order. Generic character: male, flowers four to nine, among whorled roots, heaped into a little ball; calyx sub-globular, pubescent, one-celled; consisting of a double membrane; corolla none, unless it be the inner membrane of the calyx; stamen an upright pillar placed on the base of the calyx: female in the middle of the ball, solitary; calyx and corolla as in the males; pistils; germs about fifteen, obliquely ovate, blunt, rugged with dots, each on distinct pedicles, fastened to the bottom of the calyx; style none; stigma a dot on the top of the germ; pericarpium none; seeds as many as there are germs, and of the same form. The male and female flowers may be distinguished in the dry plant, before the calyxes open, by the size of the protuberant grains.

SALUTATION, the act of saluting, greeting, or paying respect and reverence to any one. There is a great variety in the forms of salutation. The orientals salute by uncovering their feet, laying their hands on their breast, &c. In England, we salute by uncovering the head, bending the body, &c. The pope formerly paid reverence to none except the emperor, to whom he stooped a very little, when he permitted him to kiss his lips. A prince, or person of extraordinary quality, is saluted at his entering a garrison by the firing of the cannon round the place. In the field, when a regiment is to be reviewed by a king, or his general, the drums beat as he approaches, and the officers salute him, one after another, as he passes by, stepping back with the right foot and hand, bowing their half pikes to the ground, and then recovering them gently, bringing up the foot and hand, and planting them; which done, they pull off their hats without bowing. The ensigns salute all together, bringing down their colours near the ground directly before them, at one motion, and having taken them up again, gently lift their hats. At sea, they salute by a discharge of cannon, which is greater or less, according to the degree of respect they would show; and here ships always salute with an odd number of guns, and galleys with an even one. To salute with muskets is to fire one, two, or three vollies; which is a method of salutation that sometimes precedes that of cannon, and is chiefly used on occasion of feasts. After the cannon, they also sometimes salute or hail with the voice, by a joint shout of all the ship's company, repeated three times; which salutation also occasionally obtains, where they carry no guns, or do not care to discharge any. Saluting with the flag is performed two ways, either by holding it close to the staff so as it cannot flutter, or by striking it so as it cannot be seen at all, which is the most respectful. Saluting with the sails is performed by hovering the topsails half-way of the masts. Only those vessels that carry no guns salute with the sails.

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The following regulations on this subject are deserving of notice: "When any of his Majesty's ships shall meet with any ship or ships belonging to any foreign prince or state, within his Majesty's seas, (which extend to Cape Finisterre,) it is expected that the said foreign ships do strike their topsail, and take in their flag, in acknowledgment of his Majesty's sovereignty in those seas: and if any shall refuse, or offer to resist, it is enjoined to all flag-officers and commanders to use their utmost endeavours to compel them thereto, and not suffer any dishonour to be done to his Majesty. And if any of his Majesty's subjects shall so much forget their duty, as to omit striking their top-sails in passing by his Majesty's ships, the name of the ship and master, and from whence, and whither bound, together with affidavits of the facts, are to be sent up to the Secretary of the Admiralty, in order to their being proceeded against in the Admiralty Court. And it is to be observed, that in his Majesty's seas, his Majesty's ships are in nowise to strike to any; and that in no other parts, no ship of his Majesty is to strike her flag or topsail to any foreigner, unless such foreign ship shall have first struck, or at the same time strike her flag or topsail to his Majesty's ship. The flag-officers and commanders of his Majesty's ships are to be careful to maintain his Majesty's honour upon all occasions, giving protection to his subjects, and endeavouring, what in them lies, to secure and encourage them in their lawful commerce; and they are not to injure, in any manner, the subjects of his Majesty's friends and allies."

SAMARA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Rhamni, Jussieu. Essential character: calyx four-parted; corolla four-petalled; stamina immersed in the base of the petal; drupe one-seeded. There are four species.

SAMBUCUS, in botany, *elder*, a genus of the Pentandria Trigynia class and order. Natural order of Dumosæ. Caprifoliæ, Jussieu. Essential character: calyx five-parted; corolla five-cleft; berry three-seeded. There are five species.

SAMIELS, the Arabian name for a hot suffocating wind peculiar to the desert of Arabia. It blows over the deserts in the months of July and August from the north-west, and sometimes it continues its progress to the very gates of Bagdad, but it is said never to affect any person within the walls. It often passes with the quickness of lightning: and there is no way of avoiding the dire effects but by falling on the ground, and keeping the face close to the earth. Those who are negligent of this caution experience instant death.

SAMOLUS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Preciæ. Lysimachiæ, Jussieu. Essential character: corolla salver-shaped; stamina fenced by the scalelets of the corolla; capsule one-celled, inferior. There is but one species, *viz.* S. valerandi, brookweed, or water pimpernel; this plant is an inhabitant of every quarter of the globe, in marshes, wet meadows, and ditches; Mr. Miller considers it as an annual; Linnæus marks it as biennial; and others as perennial.

SAMYDA, in botany, a genus of the Decandria Monogynia class and order. Essential character: calyx five-parted, coloured; corolla none; nest bell-shaped, staminiferous; capsules berried within, four-valved, one-celled; seeds nestling. There are nine species.

SAND, in natural history, a genus of fossils, the characters of which are, that they are found in minute concretions; forming together a kind of powder, the genuine particles of which are all of a tendency to one determinate shape, and appear regular, though more or less complete concretions; not to be dissolved or disunited by water, or formed into a coherent mass by means of it, but retaining their figure in it; transparent, vitrifiable by extreme heat, and not dissoluble in, nor effervescing with, acids. See SAND-STONE.

Sand is of great use in the glass manufacture; the white writing sand being employed for making of the white glass, and a coarse greenish-looking sand for the green glass. In agriculture it seems to be the office of sands to make unctuous earths fertile, and fit to support vegetables, &c. For earth alone, we find, is liable to coalesce, and gather into a hard coherent mass, as appears in clay; and being thus embodied, and as it were glued together, is no way disposed to nourish vegetables.

Common sand is a very good addition, by way of manure, to all sorts of clay-lands; it warms them, and makes them more open and loose. The best sand for the farmer's use is that which is washed by rains from roads or hills, or that which is taken from the beds of rivers; the common sand that is dug in pits, never answers nearly so well. However, if mix-

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ed with dung, it is much better than laid on alone: and a very fine manure is made by covering the bottom of sheep-folds with several loads of sand every week, which are to be taken away and laid on cold stiff lands, impregnated as they are with the dung and the urine of the sheep.

Beside clay-land, there is another sort of ground very improvable by sand; this is that sort of black boggy land on which bushes and sedge grow naturally, and which they cut into turf in some places. Six hundred loads of sand being laid upon an acre of this land, according to the Cheshire measure, which is near double the statute acre, meliorate it so much, that without ploughing it will yield good crops of oats or tares, though before it would have produced scarcely any thing. If this crop is taken off, the land will be well dunged, and if then laid down for grass, it will yield a large crop of sweet hay.

Once sanding this land will improve it for a vast number of years, and it will yield two crops of hay in the year, if there be weather to make it in. Some land in Cheshire has been, by this means, rendered of twelve times its former value to the owner. The bogs of Ireland, when drained, have been rendered very fruitful land, by mixing sand in this manner among the earth of which they consist. Add to this, that in all these boggy lands, the burning them, or firing their own turf upon them, is also a great advantage. The common peat, or turf ashes, mixed with the sand for these purposes, add greatly to its virtue. Sea-sand, which is thrown up in creeks and other places, is by much the richest of all sand for manuring the earth; partly its saltness, and partly the fat and unctuous filth that is mixed among it, give it this great virtue. In the western parts of England, that lie upon the sea-coast, they make very great advantages of it. The fragments of sea-shells also, which are always in great abundance in this sand, add to its virtues; and it is always the more esteemed by the farmers, the more of these fragments there are among it.

The sea-sand used as manure in different parts of the kingdom, is of three kinds: that about Plymouth, and on other of the southern coasts, is of a blue-grey colour, like ashes, which is probably owing to the shells of muscles, and other fish of that or the like colour, being broken and mixed among it in great quantity. Westward, near the Land's End, the sea-sand is very white, and about the isles of Scilly it is very glistening, with small particles of talc; on the coasts of the North Sea, the sand is yellowish, brown, or reddish, and contains so great a quantity of fragments of cockle-shells, that it seems to be chiefly composed of them. The sea sand is accounted best which is of a reddish colour, the next in value to this is the bluish, and the white is the worst of all. Sea-sand is best when taken up from under the water, or from sand-banks which are covered by every tide. The small grained sand is most sudden in its operation, and is therefore best for the tenant, who is only to take three or four crops; but the coarse or large grained sand is much better for the landlord, as the good it does lasts many years.

Sand *bags*, in the art of war, are bags filled with earth or sand, holding each about a cubic foot; their use is to raise parapets in haste, or to repair what is beaten down.

Sand *flood*, a terrible mischief, incident to the lands of Suffolk, and some other parts of England, which are frequently covered with vast quantities of sand, rolling in upon them, like a deluge of water, from sandy hills in their neighbourhood.

The flowing of sand, though far from being so tremendous and hurtful as in Arabia, is of very bad consequences in this country, as many valuable pieces of land have thus been entirely lost; of which we give the following instances from Mr. Pennant, together with a probable means of preventing them in future. "I have more than once," says he, "on the eastern coasts of Scotland, observed the calamitous state of several extensive tracts, formerly in a most flourishing condition, at present covered with sands, unstable as those of the deserts of Arabia. The parish of Furvic, in the county of Aberdeen, is now reduced to two farms, and above 500*l.* a year lost to the Errol family, as appears by the oath of the factor in 1600, made before the Court of Session, to ascertain the minister's salary. Not a vestige is to be seen of any buildings, unless a fragment of the Church. The estate of Coubin, near Forres, is another melancholy instance. This tract was once worth 300*l.* a year, at this time overwhelmed with sand. This strange inundation was still in motion in 1769, chiefly when a strong wind prevailed. Its motion is so rapid that I have been assured, that an apple tree had been so covered with it in one season, that only the very summit appeared. This distress

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was brought on about ninety years ago, and was occasioned by the cutting down some trees, and pulling up the bent or star which grew on the sand hills; which at last gave rise to the act of 15 George II. c. 33, to prohibit the destruction of this useful plant.

"I beg leave to suggest to the public a possible means of putttng a stop to these destructive ravages. Providence hath kindly formed this plant to grow only in pure sand. Mankind was left to make, in after times, an application of it suitable to their wants. The sand-hills on a portion of the Flintshire shores, in the parish of Llanasa, are covered with it naturally, and keep firm in their place. The Dutch perhaps owe the existence of part, at least, of their country to the sowing of it on the *mobile solum*, their sand-banks. My humane and amiable friend, the late Benjamin Stillingfleet, Esq. recommended the sowing of this plant on the sandy wilds of Norfolk, that its matted roots might prevent the deluges of sand which that country experiences. It has been already remarked, that wheresoever this plant grows, the salutary effects are soon observed to follow. A single plant will fix the sand, and gather it into a hillock; these hillocks, by the increase of vegetation, are formed into larger, till by degrees a barrier is made often against the encroachments of the sea, and might as often prove preventive of the calamity in question. I cannot, therefore, but recommend the trial to the inhabitants of many parts of North Britain. The plant grows in most places near the sea, and is known to the Highlanders by the name of murah; to the English by that of bent-star, mat-grass, or marram. Linnæus calls it arundo arenaria. The Dutch call it helm. This plant hath stiff and sharp-pointed leaves, growing like a rush, a foot and a half long: the roots both creep and penetrate deeply into their sandy beds: the stalk bears an ear five or six inches long; not unlike rye; the seeds are small, brown, and roundish. By good fortune, as old Gerard observes, no cattle will eat or touch this vegetable, allotted for other purposes, subservient to the use of mankind."

Sand *stone*, in mineralogy, is chiefly composed of quartz, in rounded grains of various sizes. Sand-stones are stratified, and when disintegrated they form sand. We have many varieties; as, 1. "The calcareous sand-stone," which is of a green or greyish colour: it is moderately hard, and gives sparks when struck against steel. It effervesces with acids: when freed from the calcareous cement, there remains a very friable moss of fine white sand. 2. "The ferruginous sand-stone," which is of a reddish brown; it is opaque and soft, and seldom effervesces with acids: it readily disintegrates by exposure to the weather. 3. "Grit-stone," which rarely effervesces with acids, but gives very lively sparks when struck with the steel. It is not easily decomposed by exposure to the air. Sand-stone is applied to many important purposes in building, as flag-stones: and the harder kinds of grit-stone are made into grind-stones, and on account of their infusibility they are employed for lining furnaces.

SANDARACH, See Resin.

Sandarach, in natural history, a very beautiful native fossil, though too often confounded with the common factitious red arsenic, and with the red matter formed by melting the common yellow orpiment. It is a pure substance, of a very even and regular structure, is throughout of that colour which our dyers term an orange-scarlet, and is considerably transparent even in the thickest pieces. But though with respect to colour it has the advantage of cinnabar, while in the mass, it is vastly inferior to it when both are reduced to powder. It is moderately hard and remarkably heavy; and when exposed to a moderate heat, melts and flows like oil. If set on fire, it burns very briskly.

It is found in Saxony and Bohemia, in the copper and silver mines, and is sold to the painters, who find it a very fine and valuable red; but its virtues or qualities in medicine are no more ascertained at this time than those of the yellow orpiment.

SANDORICUM, in botany, a genus of the Decandria Monogynia class and order. Essential character: calyx five-toothed; petals five; nectary cylindrical, truncate, bearing the anthers at its mouth; drupe filled with five nuts. There is only one species, *viz.* S. indicum, a native of the Philippine and Molucca islands.

SANGUINARIA, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Rhoeadeæ. Papaveraceæ, Jussieu. Essential character: calyx two-leaved; corolla eight-petalled; silique ovate, one-celled. There is only one species, *viz.* S. canadensis, Canadian sanguinaria, blood-wort, or puccoon: a native of the northern parts of America, where it grows plentifully in the woods; and in the spring, before the leaves of the trees come out, the surface of the ground is in many

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places covered with the flowers, which have some resemblance to our wood anemone: but they have short naked pedicles, each supporting one flower at top. Some of these flowers will have ten or twelve petals, so that they appear to have a double range of leaves, which has occasioned their being termed double flowers; but this is only accidental, the same roots in different years producing different flowers.

SANGUISORBA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Miscellaneæ, Linnæus. Rosaceæ, Jussieu. Essential character: calyx two-leaved, inferior; corolla superior; germ between the calyx and corolla. There are three species, with several varieties.

SANICULA, in botany, *sanicle*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: umbels clustered; subcapitate; fruit rugged; flowers of the disk abortive. There are three species.

SANTALUM, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Onagræ, Jussieu. Essential character: calyx four-toothed; corolla four-petalled, with the petals growing on the calyx, besides four glands; berry inferior, one-seeded. There is only one species, *viz.* S. album, white and yellow sandal wood. This tree has the appearance of a myrtle, with stiff branchiate branches, jointed; in habit, leaves and inflorescence, resembling the privet. It is a native of many parts of India. In the Circar mountains, where it is wild, it is of little value, as it is generally of a small stature. On the Malabar coast it is very large, and the wood of the best kind. The difference of colour constitutes two kinds of sanders, both employed for the same purposes, and having equally a bitter taste, and an aromatic smell. With the powder of this wood a paste is prepared, with which the Chinese, Indians, Persians, Arabians, and Turks, anoint their bodies. It is likewise burnt in their houses, and yields a fragrant and wholesome smell. The greatest quantity of this wood, to which a sharp and attenuating virtue is ascribed, remains in India. The red sanders, though in less estimation, and less generally used, is sent by preference into Europe. This is the produce of a different tree, which is common on the coast of Coromandel. Some travellers confound it with the wood of Caliatour, which is used in dyeing.

The S. album, or white sanders, is brought from the East Indies, in billets about the thickness of a man's leg, of a pale-whitish colour. It is that part of the yellow sanders wood which lies next the bark. Great part of it, as met with in the shops, has no smell or taste, nor any sensible quality that can recommend it to the notice of the physician.

The S. flavum, or yellow sanders, is the interior part of the wood of the same tree which furnishes the former, is of a pale-yellowish colour, of a pleasant smell, and a bitterish aromatic taste, accompanied with an agreeable kind of pungency. This elegant wood might undoubtedly be applied to valuable medical purposes, though at present very rarely used. Distilled with water, it yields a fragrant essential oil, which thickens in the cold into the consistence of a balsam. Digested in pure spirit, it imparts a rich yellow tincture; which being committed to distillation, the spirit arises, without bringing over any thing considerable of the flavour of the sanders. The residuum contains the virtues of six times its weight of the wood.

SANTOLINA, in botany, *lavender cotton*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Discoideæ. Corymbiferæ Jussieu. Essential character: calyx imbricate, hemispherical; down none; receptacle chaffy. There are six species, S. chamæcyparissus, common lavender cotton, grows naturally in the southern parts of Europe, and is much cultivated in English gardens. All the species are ornamental plants, and may be propagated by planting slips and cuttings in the spring.

SAP. See PLANT.

The sap of trees, chemically considered, is a watery mucilaginous liquid, often strongly saccharine, so as to yield a large quantity of sugar, and to furnish a very strong fermented liquor.

SAP, or SAPP, in the art of war, is the digging deep under the earth of the glacis, in order to open a covered passage into the moat. It is only a deep trench, covered at top with boards, hurdles, earth, sand-bags, &c. and is usually begun five or six fathoms from the saliant angle of the glacis.

SAPPHIC, in poetry, a kind of verse much used by the Greeks and Latins, denominated from the inventress Sappho. The sapphic verse consists of five feet,

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whereof the first, fourth, and fifth, are trochees, the second a spondee, and the third a dactyle; as in

1	2	3	4	5
Aure-	*am quis*	*quis medi*	*ocri-*	*tatem*
Dili	*git, tu-*	*tus caret*	*obso*	*leti*
Sordi	*bus te-*	*citi, caret*	*invi-*	*denda.*

And after every three sapphic verses there is generally subjoined an adonic verse, as

Sobrius aulâ.

SAPINDUS, in botany, *soap-berry tree*, a genus of the Octandria Trigynia class and order. Natural order of Trihilatæ. Sapindi, Jussieu. Essential character: calyx four-leaved; petals four; capsule fleshy, connate, ventricose. There are thirteen species; of which we shall notice the S. saponaria, with winged leaves, which grows naturally in the islands of the West Indies, where it rises with a woody stalk from 20 to 30 feet high, sending out many branches with winged leaves, composed of several pair of spear-shaped lobes. The flowers are produced in loose spikes at the end of the branches; they are small and white, so make no great appearance. These are succeeded by oval berries as large as middling cherries, sometimes single, at others, two, three, or four, are joined together; these have a saponaceous skin or cover, which incloses a very smooth roundish nut of the same form, of a shining black when ripe. The skin or pulp, which surrounds the nuts, is used in America to wash linen; but it is very apt to burn or destroy it if often used, being of a very acrid nature.

SAPONARIA, in botany, *soap-wort*, a genus of the Decandria Digynia class and order. Natural order of Caryophyllei. Caryophylleæ, Jussieu. Essential character: calyx one-leafed, naked; petals five, clawed; capsule oblong, one-celled. There are nine species. S officinalis, a British plant, has a creeping plant, so that in a short time it would fill a large space of ground. The stalks are above two feet high, and of a purplish colour. The foot-stalks of the flowers arise from the wings of the leaves opposite; they sustain four, five, or more purple flowers each, which have generally too small leaves placed under them. The stalk is almost terminated by a loose bunch of flowers growing in form of an umbel; they have each a large swelling cylindrical empalement, and five broad obtuse petals, which spread open, of a purple colour. These are succeeded by oval capsules, with one cell filled with small seeds. The decoction of this plant is used to clean and scour woollen clothes: the poor people in some countries use it instead of soap for washing; from which use it had its name.

SAPPHIRE. See Corundum, where we have given the analysis of the blue corundum, or sapphire. It is infusible without addition before the blow-pipe, but with borax it melts with effervescence. Sapphire, an oriental ruby, of which an analysis is also given in the article Corundum, are, next to the diamond, the most valuable of precious stones, and are used in the finest kind of jewelry. The oriental ruby differs from the sapphire in its colour: it is also softer and of less specific gravity. In its geognostic character, it differs also from the ruby, as it occurs sometimes imbedded in corundum, which is an inmate of primitive mountains, while sapphire appears to be a production of a later period. The violet coloured sapphire is the oriental amethyst: the yellow, the oriental chrysolite and topaz; and the green, the oriental emerald.

SARACA, in botany, a genus of the Diadelphia Hexandria class and order. Natural order of Lomentaceæ. Essential character: calyx none; corolla funnel-form, four-cleft; filaments three on each side the throat; legume pedicelled. There is but one species, *viz.* S. indica, a native of the East Indies.

SARCOCOL, in chemistry, a gum resin, supposed to be the product of the penæa sarcocolla. It is brought from Persia and Arabia, in the form of small grains: they have a sweet and bitterish taste, and are very soluble in water.

SARMENTACACEÆ, in botany, the name of the eleventh class in Linnæus's Fragments of a Natural Method, consisting of plants that have climbing stems and branches, which, like the vine, attach themselves to the bodies in their neighbourhood, for the purpose of support.

SAROTHRA, in botany, a genus of the Pentandria Trigynia class and order. Natural order of Rotaceæ. Caryophylleæ, Jussieu. Essential character: calyx five-parted; corolla five-petalled; capsule one-celled, three-valved, coloured. There is but one species, *viz.* S. gentianoides, an annual plant, and a native of Virginia and Pennsylvania, growing abundantly in the fields, and under the bushes, in a dry

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sandy ground, near the capital of the latter province

SARRACENIA, in botany, *side-saddle flower*, so named in honour of Dr. Sarrazin, professor of botany, a genus of the Polyandria Monogynia class and order. Natural order of Succulentæ. Essential character: calyx double, three-leaved, and five-leaved; corolla five-petalled; capsule five-celled, with the style having a clypeate stigma. There are four species, all natives of North America.

SARSAPARILLA, in pharmacy, the root of the rough smilax of Peru, consisting of a great number of long strings hanging from one head: these long roots, the only parts made use of, are about the thickness of a goose-quill, or thicker, flexible, and composed of fibres running their whole length: they have a bitterish but not ungrateful taste, and no smell: and as to their medicinal virtues, they are sudorific and attenuant, and should be given in decoction, or by way of diet-drink.

SASH, a mark of distinction, which, in the British service, is generally made of crimson silk for the officers, and of crimson mixed with white cotton for the serjeants. It is worn round the waist in most regiments; in some few, particularly in the Highland corps, it is thrown across the shoulder. Sashes were originally invented for the convenience and ease of wounded officers, &c. by means of which, in case any of them were so badly wounded as to render them incapable of remaining at their posts, they might be carried off with the assistance of two men. They are now reduced to a very small size, and of course unfit for the original purpose Both the sash and gorget, indeed, must be considered as mere marks of distinction, to point out officers on duty. In some instances they are worn together; in others, the gorget is laid aside, and the sash only worn. The British cavalry tie the sash on the right, the infantry on the left side. The sashes for the imperial army are made of crimson and gold, for the Prussian army black silk and silver, the Hanoverians yellow silk, the Portuguese crimson silk with blue tassels. The French have their sashes made of three colours, *viz.* white, pink, and light-blue, to correspond with the national flag.

SASSAFRAS, in pharmacy, the wood of an American tree, of the laurel-kind, imported in large straight blocks: it is said to be warm, aperient, and corroborant; and frequently employed, with good success, for purifying the blood, for which purpose an infusion, in the way of tea, is a very pleasant drink: its oil is very fragrant, and possesses most of the virtues of the wood.

SATELLITES, in astronomy, are certain secondary planets, moving round the other planets, as the Moon does round the Earth. They are so called because they always attend them, and make the tour about the Sun together with them. The words moon and satellite are sometimes used indifferently: thus, we say, either Jupiter's moons, or Jupiter's satellites; but usually we distinguish, restraining the term moon to the Earth's attendant, and applying the term satellite to the little moons more recently discovered about Jupiter, Saturn, and the Herschel planet, by the assistance of the telescope, which is necessary to render them visible.

The satellites move round their primary planets, as their centres, by the same laws as those primary ones do round their centre the Sun; *viz.* in such manner, that, in the satellites of the same planet, the squares of the periodic times are proportional to the cubes of their distances from the primary planet.

SATELLITES *of Jupiter*, are four little moons, or secondary planets, performing their revolutions about Jupiter, as that planet does about the Sun.

Simon Marius, mathematician of the Elector of Brandenburgh, about the end of November 1609, observed three little stars moving round Jupiter's body, and proceeding along with him; and in January, 1610, he found a fourth. In January, 1610, Gallileo also observed the same in Italy, and in the same year, published his observations. These satellites were also observed in the same month of January, 1610, by Thomas Harriot, the author of a work upon algebra, and who made constant observations on these satellites, from that time till the 26th of February, 1612.

When Jupiter comes into a line between any of his satellites and the Sun, the satellite disappears, being then eclipsed, or involved in his shadow. When the satellite goes behind the body of Jupiter, with respect to an observer on the Earth, it is then said to be occulted, being hidden from our sight by his body, whether in his shadow or not. And when the satellite comes into a position between Jupiter and the Sun, it casts a shadow upon the face of that planet, which we see as an obscure round spot. And

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lastly, when the satellite comes into a line between Jupiter and us, it is said to transit the disk of the planet, upon which it appears as a round black spot. The periods or revolutions of Jupiter's satellites are found out from their conjunctions with that planet, after the same manner as those of the primary planets are discovered from their opposition to the Sun. And their distances from the body of Jupiter are measured by a micrometer, and estimated in semi-diameters of that planet, and thence in miles. The periodical times and distances of these satellites, and the angles under which their orbits are seen from the Earth, at its mean distance, from Jupiter, are as below.

Satellites.	Periodic Times.	Distances in		Angles of Orbit.
		Semi-diameter.	Miles.	
1	$1^d\ 18^h\ 27'\ 34''$	$5\frac{2}{3}$	266,000	$3'\ 55''$
2	3 13 13 42	$9\frac{1}{60}$	423,000	6 14
3	7 3 42 36	$14\frac{5}{13}$	676,000	9 58
4	16 16 32 9	$25\frac{3}{10}$	1,189,000	17 30

The eclipses of the satellites, especially of those of Jupiter, are of very great use in astronomy. First, in determining pretty exactly the distance of Jupiter from the earth. A second advantage, still more considerable, which is drawn from these eclipses, is the proof which they give of the progressive motion of light. It is demonstrated by these eclipses, that light does not come to us in an instant, although its motion is extremely rapid. For if the motion of light were infinite, or came to us in an instant, it is evident that we should see the commencement of an eclipse of a satellite at the same moment, at whatever distance we might be from it; but, on the contrary, if light move progressively, then, it is as evident, that the further we are from a planet, the later we shall be in seeing the moment of its eclipse, because the light will take up a longer time in arriving at us; and so it is found in fact to happen, the eclipses of these satellites appearing always later and later than the true computed times, as the Earth removes further and further from the planet. When Jupiter and the Earth are at their nearest distance, being in conjunction both on the same side of the Sun, then the eclipses are seen to happen the soonest; and when the Sun is directly between Jupiter and the Earth they are at their greatest distance asunder, the distance being more than before by the whole diameter of the Earth's annual orbit, or by double the Earth's distance from the Sun; then the eclipses are seen to happen the latest of any, and later than before by about a quarter of an hour. Hence, therefore, it follows, that light takes up a quarter of an hour in travelling across the orbit of the Earth, or nearly eight minutes in passing from the Sun to the Earth; which gives us about 12 millions of miles per minute, or 200,000 miles per second, for the velocity of light. A discovery that was first made by Mr. Roemer.

The third and greatest advantage derived from the eclipses of the satellites, is the knowledge of the longitudes of places on the Earth. Suppose two observers of an eclipse, the one, for example, at London, the other at the Canaries; it is certain that the eclipse will appear at the same moment to both observers; but as they are situated under different meridians, they count different hours, being perhaps 9 o'clock to the one, when it is only 8 to the other; by which observations of the true time of the eclipse, on communication, they find the difference of their longitudes to be one hour in time, which answers to 15 degrees of longitude.

Saturn has seven secondary planets revolving about him. One of them, which till lately was reckoned the fourth in order from Saturn, was discovered by Huygens, the 25th of March, 1655, by means of a telescope 12 feet long; and the first, second, third, and fifth, at different times, by Cassini, *viz.* the fifth in October, 1671, by a telescope of 17 feet; the third in December, 1672, by a telescope of Campani's, 35 feet long; and the first and second in March, 1684, by help of Campani's glasses, of 100 and 136 feet. Finally, the sixth and seventh satellites were discovered by Dr. Herschel, with his 40 feet reflecting telescope, *viz.* the sixth on the 19th of Agust, 1787, and the seventh on the 17th of September, 1788. These two he has called the sixth and seventh satellites, though they are nearer to the planet Saturn than any of the former five, that the names or numbers of these might not be mistaken or confounded, with regard to former observations of them.

Moreover, the great distance between the fourth and fifth satellite gave occasion to Huygens to suspect that there

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might be some intermediate one, or else that the fifth might have some other satellite moving round it, at its centre. Dr. Halley, in the Philosophical Transactions, gives a correction of the theory of the motions of the fourth or Huygenian satellite. Its true period he makes $11^d\ 22^h\ 41'\ 6''$.

The periodical revolutions, and distances of the satellites from the body of Saturn, expressed in semidiameters of that planet, and in miles, are as follow:

Satellites.	Periods.	Distances in Semidiameters.	Distances in Miles.	Diam. or Orbit
1	$1^d\ 21^h\ 18'\ 27''$	$4\frac{3}{4}$	170,000	$1'\ 27''$
2	2 17 41 22	$5\frac{1}{2}$	217,000	1 52
3	4 12 25 12	8	303,000	2 36
4	15 22 41 13	18	704,000	6 18
5	79 7 43 0	54	2,050,000	17 4
6	1 8 58 9	$3\frac{1}{2}$	135,000	1 14
7	0 22 40 46	$2\frac{5}{8}$	107,000	0 57

The four first describe ellipses like to those of the ring, and are in the same plane. Their inclination to the ecliptic is from 30 to 31 degrees. The fifth describes an orbit inclined from 17 to 18 degrees with the orbit of Saturn; his plane lying between the ecliptic and those of the other satellites, &c. Dr. Herschel observes, that the fifth satellite turns once round its axis exactly in the time in which it revolves about the planet Saturn; in which respect it resembles our Moon, which does the same thing. And he makes the angle of its distance from Saturn, at his mean distance, $17'\ 2''$. Philosophical Transactions, 1792, p. 22. See a long account of observations of these satellites, with tables of their mean motions, by Dr. Herschel. Philosophical Transactions, 1790.

The Herschel has six satellites, or moons, that revolve about him, like those of Jupiter and Saturn. These satellites were discovered by Dr. Herschel, who gave an account of them in the Philosophical Transactions.

SATIN, a glossy kind of silk stuff, the warp of which is very fine, and stands out so as to cover the coarser woof. Some satins are quite plain, others wrought; some flowered with gold or silver, and others striped, &c. The Chinese satins are most valued, because of their cleaning and bleaching easily, without losing any thing of their lustre; in other respects they are inferior to those of Europe.

SATINET, a slight thin kind of satin, commonly striped, and chiefly used by the ladies for summer night gowns.

SATURATION, in chemistry. As there are certain limits to the proportions in which bodies combine together, beyond which they cannot pass, these are called the points of saturation; and when two bodies, in uniting together, have reached this point, they are said to be saturated, or the one body is said to be saturated with the other; in other words, the change has taken place, and a new compound is formed. When, for instance, a salt is dissolved in water, as common salt, the water combines only with a certain proportion; and whatever quantity of salt is added beyond this proportion, it falls to the bottom undissolved. The reason of this is, that the particles of the salt are held together by their affinity for each other; that is, by the force of cohesion. Now, before any combination can be effected between the particles of the salt and the water, this force must be overcome. The force of affinity, therefore, between the water and the particles of salt, is greater than that between the particles of salt themselves, and thus they are separated and dissolve in the water; but this force of affinity between the water and the salt is limited; and when it has arrived at its utmost limit, the action between the two bodies ceases. The two forces which were opposed to each other; that is, the force of affinity between the water and the salt on the one hand, and the force of cohesion between the particles of the salt on the other, are balanced. The water in this case is said to be saturated with salt.

SATUREIA, in botany, *savory*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: corolla with segments nearly equal; stamina distant. There are eight species, S. hortensis, or summer savory, is an annual plant, which grows naturally in the south of France and Italy, but is cultivated in this country both for the kitchen and medicinal use. The S. montana, or winter savory, a perennial plant, growing naturally in the south of France and Italy, but it is cultivated in gardens, both for culinary and medicinal purposes. Both kinds are propagated by seeds.

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Summer savory is a very warm pungent aromatic, and affords in distillation with water a subtile essential oil, of a penetrating smell, and very hot acrid taste.

SATURN is a very conspicuous planet, though not so brilliant as Jupiter. The period of his sidereal revolution round the earth is 10,759 days. He moves from west to east nearly in the plane of the ecliptic, and exhibits irregularities similar to those of Jupiter and Mars. He becomes retrograde both before and after his opposition, when at the distance of about 109° from the sun. His retrograde motion continues about 139 days, and during its continuance he describes an arc of about 6°. His diameter is a maximum at his opposition, and his mean apparent diameter is 18″. Saturn, when viewed through a good telescope, makes a more remarkable appearance than any of the other planets. Galileo first discovered his uncommon shape, which he thought to be like two small globes, one on each side of a large one, and he published his discovery in a Latin sentence, the meaning of which was, that he had seen him appear with three bodies, though, in order to keep the discovery a secret, the letters were transposed. Having viewed him for two years, he was surprised to see him become quite round, without these appendages, and then, after some time, to assume them as before. These adjoining globes were what are now called the ansæ of his ring, the true shape of which was first discovered by Huygens, about forty years after Galileo, first with a telescope of twelve feet, and then with one of twenty-three feet, which magnified objects one hundred times. From the discoveries made by him and other astronomers, it appears that this planet is surrounded by a broad thin ring, the edge of which reflects little or none of the Sun's light to us, but the planes of the ring reflect the light in the same manner that the planet itself does; and if we suppose the diameter of Saturn to be divided into three equal parts, the diameter of the ring is about seven of these parts. The ring is detached from the body of Saturn in such a manner, that the distance between the innermost part of the ring and the body is equal to its breadth. Both the outward and inward rim of the ring is projected into an ellipsis, more or less oblong, according to the different degrees of obliquity with which it is viewed. Sometimes our eye is in the plane of the ring, and then it becomes invisible, either because the outward edge is not fitted to reflect the Sun's light, or more probably because it is too thin to be seen at such a distance. As the plane of this ring keeps always parallel to itself, that is, its situation in one part of the orbit is always parallel to that in any other part, it disappears twice in every revolution of the planet, that is, about once in fifteen years, and he sometimes appears quite round for nine months together. At other times, the distance between the body of the planet and the ring is very perceptible, insomuch that Mr. Whiston tells us of Dr. Clarke's father having seen a star through the opening, and supposed him to have been the only person who ever saw a sight so rare, as the opening, though certainly very large, appears very small to us.

When Saturn appears round, if our eye be in the plane of the ring, it will appear as a dark line across the middle of the planet's disk, and if our eye be elevated above the plane of the ring, a shadowy belt will be visible, caused by the shadow of the ring, as well as by the interposition of part of it between the eye and the planet. The shadow of the ring is broadest when the Sun is most elevated, but its obscure parts appear broadest, when our eye is most elevated above the plane of it. When it appears double, the ring next the body of the planet appears brightest. When the ring appears of an elliptical form, the parts about the ends of the largest axis are called the ansæ, as has been already mentioned. These, a little before and after the disappearing of the ring, are of unequal magnitude; the largest ansæ is longer visible before the planet's round phase, and appears again sooner than the other. On the first of October, 1714, the largest ansæ was on the east side, and on the twelfth on the west side, of the disk of the planet, which makes it probable that the ring has a rotation round an axis. Herschel has demonstrated, that it revolves in its own plane in 10^h $32'$ $15.4''$. The observations of this philosopher have added greatly to our knowledge of Saturn's ring. According to him there is one single, dark, considerably broad line, belt, or zone, which he has constantly found on the north side of the ring. As this dark belt is subject to no change whatever, it is probably owing to some permanent construction of the surface of the ring: this construe-

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tion cannot be owing to the shadow of a chain of mountains, since it is visible all round on the ring; for there could be no shade at the ends of the ring; a similar argument will apply against the opinions of very extended caverns. It is pretty evident that this dark zone is contained between two concentric circles, for all the phenomena correspond with the projection of such a zone. The nature of the ring Dr. Herschel thinks no less solid than that of Saturn itself, and it is observed to cast a strong shadow upon the planet. The light of the ring is also generally brighter than that of the planet, for the ring appears sufficiently bright when the telescope affords scarcely light enough for Saturn. The Doctor concludes that the edge of the ring is not flat, but spherical, or spheroidical. The dimensions of the ring, or of the two rings with the space between them, Dr. Herschel gives below:

Inner diameter of smaller ring	146,345
Outside diameter of ditto -	184,393
Inner diameter of larger ring	190,248
Outside diameter of ditto -	204,883
Breadth of the inner ring -	20,000
Breadth of the outer ring -	7,200
Breadth of the vacant space, or dark zone - - - -	2,339

There have been various conjectures relative to the nature of this ring. Some persons have imagined that the diameter of the planet Saturn was once equal to the present diameter of the outer ring, and that it was hollow, the present body being contained within the former surface, in like manner as a kernel is contained within its shell; they suppose that, in consequence of some concussion, or other cause, the outer shell all fell down to the inner body, and left only the ring at the greater distance from the centre, as we now perceive it. This conjecture is in some measure corroborated by the consideration, that both the planet and its ring perform their rotations about the same common axis, and in very nearly the same time. But from the observations of Dr. Herschel, he thus concludes: "It does not appear to me that there is sufficient ground for admitting the ring of Saturn to be of a very changeable nature, and I guess that its phenomena will hereafter be so fully explained, as to reconcile all observations. In the meanwhile we must withhold a final judgment of its construction, till we can have more observations. Its division, however, into two very unequal parts can admit of no doubt." The diameters of Saturn are not equal: that which is perpendicular to the plane of his ring appears less by one-eleventh than the diameter situated in that plane. If we compare this form with that of Jupiter, we have reason to conclude that Saturn turns rapidly round his shorter axis, and that the ring moves in the plane of his equator. Herschel has confirmed this opinion by actual observation. He has ascertained the duration of a revolution of Saturn round his axis to amount to 0.428 day. Huygens observed five belts upon this planet nearly parallel to the equator.

SATYRIUM, in botany, a genus of the Gynandria Diandria class and order Natural order of Orchideæ. Essential character; nectary serotiform, or twin-inflated behind the flower. There are twenty-one species.

SAUCISSE, or Sausage, in the military art, a long train of powder, sewed up in a roll of pitched cloth, about two inches in diameter, serving to set fire to mines. There are usually two saucisses extended from the chamber of the mine, to the place where the engineer stands; that in case one should fail, the other may take effect

SAUCISSON, in fortification, a mass of large branches of trees bound together; and differing only from a fascine, as this is composed of small branches of twigs. Saucissons are employed to cover the men, and to make epaulements.

SAVILLE, (Sir Henry,) in biography, a very learned Englishman, the second son of Henry Saville, Esq. was born at Bradley, near Halifax, in Yorkshire, November the 30th, 1549. He was entered of Merton College, Oxford, in 1561, where he took the degrees in arts, and was chosen fellow. When he proceeded master of arts, in 1570, he read, for that degree, on the Almagest of Ptolemy, which procured him the reputation of a man eminently skilled in mathematics, and the Greek language; in the former of which he voluntarily read a public lecture in the University for some time.

In 1578, he travelled into France, and other countries; where diligently improving himself in all useful learning, in languages and the knowledge of the world, he became a most accomplished gentleman. At his return, he was made tutor in the Greek tongue to Queen Elizabeth, who had a great esteem and respect for him.

In 1585, he was made Warden of Mer-

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ton College, which he governed six and thirty years with great honour, and improved it by all the means in his power. In 1596, he was chosen Provost of Eton College; which he filled with many learned men. James I. upon his accession to the crown of England, expressed a great regard for him, and would have preferred him either in church or state; but Saville declined it, and only accepted the ceremony of knighthood, from the King, at Windsor, in 1604. His only son, Henry, dying about that time, he henceforth devoted his fortune to the promoting of learning. Among other things, in 1619, he founded, in the University of Oxford, two lectures, or professorships, one in geometry, the other in astronomy; which he endowed with a salary of 160*l.* a year each, besides a legacy of 600*l.* to purchase more lands for the same use. He also furnished a library with mathematical books, near the mathematical school, for the use of his professors; and gave 100*l.* to the mathematical chest of his own appointing; adding afterwards a legacy of 40*l.* a year to the same chest, to the University, and to his professors jointly. He likewise gave 120*l.* towards the new building of the schools, besides several rare manuscripts and printed books to the Bodleian Library; and a good quantity of Greek types to the printing-press at Oxford.

After a life thus spent in the encouragement and promotion of science and literature in general, he died at Eton College, the 19th of February, 1622, in the seventy-third year of his age, and was buried in the chapel there. On this occasion the University of Oxford paid him the greatest honours, by having a public speech and verses made in his praise, which were published soon after in 4to. under the title of "Ultima Linea Savillii."

As to the character of Saville, the highest encomiums are bestowed upon him by all the learned of his time; by Casaubon, Mercerus, Meibomius, Joseph Scaliger, and especially the learned Bishop Montague, who, in his "Diatribæ upon Selden's History of Tythes," styles him, "that magazine of learning, whose memory shall be honourable amongst not only the learned, but the righteous, for ever."

Several noble instances of his munificence to the republic of letters have already been mentioned: in the account of his publications, many more, and even greater, will appear. These are,

1. Four Books of the Histories of Cornelius Tacitus, and the Life of Agricola, with Notes upon them, in folio; dedicated to Queen Elizabeth, 1581.

2. A view of certain Military Matters, or Commentaries respecting Roman Warfare. 1598.

4. Rerum Anglicarum Scriptores post Bedam, &c. 1596. This is a collection of the best writers of our English History, to which he added chronological tables at the end, from Julius Cæsar to William the Conqueror.

4. The works of St. Chrysostom, in Greek, in eight volumes, folio, 1613. This is a very fine edition, and composed with great cost and labour. In the preface he says, "that having himself visited, about twelve years before, all the public and private libraries in Britain, and copied out of thence whatever he thought useful to his design, he then sent some learned men into France, Germany, Italy, and the East, to transcribe such parts as he had not already, and to collate the others with the best manuscripts." At the same time he makes his acknowledgments to several eminent men for their assistance; as Thuanus, Velserus, Schottus, Casaubon, Ducæus, Gruter, Hoeschelius, &c. In the eighth volume are inserted Sir Henry Saville's own notes, with those of other learned men. The whole charge of this edition, including the several sums paid to learned men, at home and abroad, employed in finding out, transcribing, and collating the best manuscripts, is said to have amounted to no less than 8000*l.* Several editions of this work were afterwards published at Paris.

5. In 1618, he published a Latin work, written by Thomas Bradwardin, Archbishop of Canterbury, against Pelagius, entitled De Causa Dei contra Pelagium, et de virtute Causarum; to which he prefixed the life of Bradwardin.

6. In 1621, he published a collection of his own Mathematical Lectures on Euclid's Elements in 4to.

7. Oratio coram Elizabetha Regina Oxoniæ habita, anno 1592. Printed at Oxford, in 1658, 4to.

8 He translated into Latin King James's Apology for the Oath of Allegiance. He also left several manuscripts behind him, written by order of King James; all which are in the Bodleian Library. He wrote notes likewise upon the margin of many books in his library, particularly Eusebius's Ecclesiastical History; which were afterwards used by Valesius, in his edition of that work, in 1659. Four of his

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Letters to Camden, are published by Smith, among Camden's Letters. 1691. 4to.

SAUNDERS, or SANDERS. See SANTATUM.

SAUNDERSON, (DR. NICHOLAS,) in biography, an illustrious professor of mathematics in the University of Cambridge, and a fellow of the Royal Society, was born at Thurlston, in Yorkshire, in 1682. When he was but twelve months old, he lost not only his eye-sight, but his very eye-balls, by the small-pox; so that he could retain no more ideas of vision than if he had been born blind. At an early age, however, being of very promising parts, he was sent to the free school at Penniston, and there laid the foundation of that knowledge of the Greek and Latin languages, which he afterwards improved so far, by his own application to the classic authors, as to hear the works of Euclid, Archimedes, and Diophantes, read in their original Greek.

Having acquired a grammatical education, his father, who was in the excise, instructed him in the common rules of arithmetic. And here it was that his excellent mathematical genius first appeared; for he very soon became able to work the common questions, to make very long calculations by the strength of his memory, and to form new rules to himself, for the better resolving of such questions as are often proposed to learners as trials of skill.

At the age of eighteen our author was introduced to the acquaintance of Richard West, of Underbank, Esq., a lover of mathematics, who, observing Mr. Saunderson's uncommon capacity, took the pains to instruct him in the principles of algebra and geometry, and gave him every encouragement in his power to the prosecution of these studies. Soon after this he became acquainted also with Dr. Nettleton, who took the same pains with him. And it was to these two gentlemen that Mr. Saunderson owed his first instruction in the mathematical sciences; they furnished him with books, and often read and expounded them to him. But he soon surpassed his masters, and became fitter to teach, than to learn any thing from them.

His father, otherwise burdened with a numerous family, finding a difficulty in supporting him, his friends began to think of providing both for his education and maintenance. His own inclination led him strongly to Cambridge, and it was at length determined he should try his fortune there, not as a scholar, but as a master; or, if this design should not succeed, they promised themselves success in opening a school for him at London. Accordingly he went to Cambridge in 1707, being then twenty-five years of age, and his fame in a short time filled the University. Newton's Principia, Optics, and Universal Arithmetic, were the foundations of his lectures, and afforded him a noble field for the display of his genius; and great numbers came to hear a blind man give lectures on optics, discourse on the nature of light and colours, explain the theory of vision, the effect of glasses, the phenomenon of the rainbow, and other objects of sight.

As he instructed youth in the principles of the Newtonian philosophy, he soon became acquainted with its incomparable author, though he had several years before left the University; and frequently conversed with him on the most difficult parts of his works: he also held a friendly communication with the other eminent mathematicians of the age, as Halley, Cotes, De Moivre, &c.

Mr. Whiston was all this time in the mathematical professor's chair, and read lectures in the manner proposed by Mr. Saunderson on his settling at Cambridge; so that an attempt of this kind looked like an encroachment on the privilege of his office; but as a good natured man, and an encourager of learning, he readily consented to the application of friends made in behalf of so uncommon a person.

Upon the removal of Mr. Whiston from his professorship, Mr. Sanderson's merit was thought so much superior to that of any other competitor, that an extraordinary step was taken in his favour, to qualify him with a degree, which the statute requires: in consequence he was chosen, in 1711, Mr. Whiston's successor in the Lucasian professorship of mathematics; Sir Isaac Newton interesting himself greatly in his favour. His first performance, after he was seated in the chair, was an inaugural speech made in very elegant Latin, and a style truly Ciceronian; for he was very well versed in the writings of Tully, who was his favourite in prose, as Virgil and Horace were in verse. From this time he applied himself closely to the reading of lectures, and gave up his whole time to his pupils. He continued to reside among the gentlemen of Christ College till the year 1723, when he took a house in Cam-

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bridge, and soon after married a daughter of Mr. Dickens, rector of Boxworth, in Cambridgeshire, by whom he had a son and a daughter.

In the year 1728, when King George visited the University, he expressed a desire of seeing so remarkable a person; and accordingly our professor attended the King in the senate, and by his favour was there created doctor of laws.

Dr. Saunderson was naturally of a strong, healthy constitution; but being too sedentary, and constantly confining himself to the house, he became a valetudinarian: and in the spring of the year 1739 he complained of a numbness in his limbs, which ended in a mortification in his foot, of which he died the 19th of April that year, in the 57th year of his age.

There was scarcely any part of the mathematics on which Dr. Saunderson had not composed something for the use of his pupils. But he discovered no intention of publishing any thing, till, by the persuasion of his friends, he prepared his Elements of Algebra for the press; which, after his death, were published by subscription, in two vols. 4to. 1740.

He left many other writings, though none perhaps prepared for the press. Among these were some valuable comments on Newton's Principia, which not only explain the more difficult parts, but often improve upon the doctrines. These are published in Latin, at the end of his posthumous Treatise on Fluxions, a valuable work, published in 8vo. 1756. His manuscript lectures too, on most parts of natural philosophy, might make a considerable volume, and prove an acceptable present to the public, if printed.

Dr. Saunderson, as to his character, was a man of much wit and vivacity in conversation, and esteemed an excellent companion. He was endued with a great regard to truth, and was such an enemy to disguise, that he thought it his duty to speak his thoughts at all times with unrestrained freedom. Hence his sentiments on men and opinions, his friendship or disregard, were expressed without reserve; a sincerity which raised him many enemies.

A blind man, moving in the sphere of a mathematician, seems a phenomenon difficult to be accounted for, and has excited the admiration of every age in which it has appeared. Tully mentions it as a thing scarcely credible in his own master in philosophy, Diodotus, that he exercised himself in it with more assiduity after he became blind; and, what he thought next to impossible to be done without sight, that he professed geometry, describing his diagrams so exactly to his scholars, that they could draw every line in its proper direction. St. Jerome relates a still more remarkable instance in Didymus, of Alexandria, who, though blind from his infancy, and therefore ignorant of the very letters, not only learned logic, but geometry also, to a very great perfection, which seems most of all to require sight. But if we consider that the ideas of extended quantity, which are the chief objects of mathematics, may as well be acquired by the sense of feeling as that of sight, that a fixed and steady attention is the principal qualification for this study, and that the blind are, by necessity, more abstracted than others, (for which reason, it is said, that Democritus put out his eyes, that he might think more intensely,) we shall perhaps find reason to suppose, that there is no branch of science so much adapted to their circumstances.

At first, Dr. Saunderson acquired most of his ideas by the sense of feeling; and this, as is commonly the case with the blind, he enjoyed in great perfection. Yet he could not, as some are said to have done, distinguish colours by that sense; for, after having made repeated trials, he used to say it was pretending to impossibilities. But he could with great nicety and exactness observe the smallest degree of roughness, or defect of polish, in a surface. Thus, in a set of Roman medals, he distinguished the genuine from the false, though they had been counterfeited with such exactness as to deceive a connoisseur who had judged from the eye. By the sense of feeling, also, he distinguished the least variation; and he has been seen in a garden, when observations have been making on the sun, to take notice of every cloud that interrupted the observation, almost as justly as they who could see it. He could also tell when any thing was held near his face, or when he passed by a tree at no great distance, merely by the different impulse of the air on his face.

His ear was also equally exact. He could readily distinguish the 5th part of a note. By the quickness of this sense he could judge of the size of a room and of his distance from the wall. And if ever he walked over a pavement, in courts or piazzas which reflected a sound, and was afterwards conducted thither

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again, he could tell in what part of the walk he had stood, merely by the note it sounded.

Dr. Saunderson had a peculiar method of performing arithmetical calculations, by an ingenious machine and method, which has been called his Palpable Arithmetic, and is particularly described in a piece prefixed to the first volume of his Algebra. That he was able to make long and intricate calculations, both arithmetical and algebraical, is a thing as certain as it is wonderful. He had contrived for his own use a commodious notation for any large numbers, which he could express on his abacus, or calculating table, and with which he could readily perform any arithmetical operations, by the sense of feeling only, for which reason it was called his Palpable Arithmetic.

His calculating table was a smooth thin board, a little more than a foot square, raised upon a small frame, so as to lie hollow, which board was divided into a great number of little squares, by lines intersecting one another perpendicularly, and parallel to the sides of the table, and the parallel ones only one-tenth of an inch from each other; so that every square inch of the table was thus divided into 100 little squares. At every point of intersection the board was perforated by small holes, capable of receiving a pin; for it was by the help of pins stuck up to the head through these holes, that he expressed his numbers. He used two sorts of pins, a large and a smaller sort; at least their heads were different, and might easily be distinguished by feeling. Of these pins he had a large quantity in two boxes, with their points cut off, which always stood ready before him when he calculated. The writer of that account describes particularly the whole process of using the machine, and concludes: "He could place and displace his pins with incredible nimbleness and facility, much to the pleasure and surprise of all the beholders. He could even break off in the middle of a calculation, and resume it when he pleased, and could presently know the condition of it, by only drawing his fingers gently over the table."

SAURURUS, in botany, a genus of the Heptandria Trigynia class and order.—Natural order of Piperitæ. Naiades, Jussieu. Essential character: calyx an ament, with one-flowered scales; corolla none: germs four; berries four, one-seeded. There is but one species, *viz.* S. cernuus, lizard's tail, a native of North America.

SAUVAGESIA, in botany, so named in honour of Francois Boissier de Sauvages, professor at Montpellier, a genus of the Pentandria Monogynia class and order. Natural order of Gruinales. Essential character: calyx five-leaved: corolla five-petalled, fringed; nectary five-leaved, alternate with the petals; capsule one-celled. There is but one species, *viz.* S. erecta, a native of St. Domingo, Martinico, Jamaica, Surinam, and Guiana.

SAW, an instrument which serves to cut into pieces several solid matters, as wood, stone, ivory, &c. The best saws are of tempered steel, ground bright and smooth: those of iron are only hammer-hardened: hence, the first, besides their being stiffer, are likewise found smoother than the last. They are known to be well hammered, by the stiff bending of the blade, and to be well and evenly ground, by their bending equally in a bow. The edge in which are the teeth is always thicker than the back, because the back is to follow the edge. The teeth are cut and sharpened with a triangular file, the blade of the saw being first fixed in a whetting block. After they have been filed, the teeth are set, that is, turned out of the right line, that they may make the fissure the wider, that the back may follow the better. The teeth are always set ranker for coarse cheap stuff than for hard and fine, because the ranker the teeth are set, the more stuff is lost in the kerf. The saws by which marble and other stones are cut have no teeth: these are generally very large, and are stretched out and held even by a frame. The workmen, who make the greatest use of the saw, are the sawyers, carpenters, joiners, cabinet-makers, ebonists, stone-cutters, carvers, sculptors, &c. The lapidaries too have their saw, as well as the workers in mosaic; but these bear little resemblance to the common saw. But, of all mechanics, none have so many saws as the joiners; the chief are as follows: the pit-saw, which is a large two-handed saw, used to saw timber in pits: this is chiefly used by the sawyers. The whip-saw, which is also two-handed, used in sawing such large pieces of stuff as the hand-saw will not easily reach. The hand-saw, which is made for a single man's use, of which there are various kinds; as the bow or frame saw, which is furnished with cheeks: by the twisted cords which pass from the upper parts of these cheeks, and the tongue in the middle of them, the upper ends are drawn closer together, and the lower set further apart. The tenon-saw, which, being very

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thin, has a back to keep it from bending. The compass-saw, which is very small, and its teeth usually not set: its use is to cut a round, or any other compass-kerf: hence the edge is made broad, and the back thin, that it may have a compass to turn in.

The surgeons also use a saw to cut off bones; this should be very small and light, in order to be managed with the greater ease and freedom, the blade exceedingly fine, and the teeth exquisitely sharpened, to make its way more gently, and yet with great expedition, in cutting off legs, arms, &c.

Saws are now generally used by butchers in separating the bones of the meat; the divisions by the saw are neater than those by the chopper, and there is a certain saving, as the chopper splinters bones, the parts of which cannot be included in the weight.

SAWING, dividing timber, &c. by the application of a saw, either by the hand or mill. The mechanism of a sawing-mill may be reduced to three principal things; the first, that the saw be drawn up and down as long as is necessary, by a motion communicated by water to the wheel: the second, that the piece of timber to be cut into boards be advanced by an uniform motion to receive the strokes of the saw; for here the wood is to meet the saw, and not the saw to follow the wood, therefore the motion of the wood and that of the saw ought immediately to depend the one on the other; the third, that when the saw has cut through the whole length of the piece, the machine stops of itself, and remains immoveable, for fear, lest, having no obstacle to surmount, the force of the water, or steam, should turn the wheel with too great rapidity, and break some part of the machine.

In Plate Saw-mill are drawings of a circular saw-mill, used by Mr. George Smart, at his manufactory for hollow-made masts, Westminster Bridge. Fig. 1, is an elevation of the machine; fig. 2, a plan; and fig. 3 and 4, the saw shown separately.

The machine is turned by a horse-wheel, which gives motion to a pinion on a horizontal shaft; a spur-wheel is fixed on this shaft, and turns a pinion on another horizontal shaft, on which the wheel A, (fig. 1.) is fixed; this wheel is in the room over the machine, and the bearings for the gudgeons of the shaft are supported on the joists, B, of the floor: by means of an endless strap passing round this wheel, and also round a pulley N, on the spindle of the circular saw, a rapid motion is given to the saw, which is made of well tempered steel plate, (fig. 3.) with teeth on its edge: it is fixed on its spindle, D, (fig. 4.) by a shoulder, *d*, against which it is held by another moveable shoulder, *e*, pressed against the other by a nut, *k*, on the end of the spindle, which is tapped into a screw to receive it. The saw has a circular hole through the middle, fitting tight upon the spindle, and a small fillet fitting into the notch, *a*, (fig. 3.) causes them to turn together.

The ends of the spindle are pointed, and that point nearest the saw works in a hole made in the end of a screw screwed in a bench, E F G H, (fig. 1. and 2.) made of stout planks, and well braced together; the other turns in a similar screw screwed through a cross beam, K, mortised between two vertical beams, L L, extending from the floor to the ceiling: the cross beam, K, can be raised or lowered in its mortises through the beams L, by wedges put both above and below its tenons. In order to adjust the plane of the saw perpendicular to the plane of the bench, M M, is a long parallel ruler, which can be set at any distance from the saw, and fixed by screws going through circular grooves, *g g*, cut through the bench. In using the machine, the ruler, M M, is to be set the proper distance from the saw of the piece of wood to be cut, and as the saw turns round, a workman slides the end of a piece of wood to it, keeping its edge against the guide, M M, that it may cut straight.

When the saw requires sharpening, one of the screws at the end of its spindle must be turned back: the spindle and saw can be then removed; and by taking off the nut, *k*, the saw will be loose, and may be fixed in a common vice to whet it, in the same manner as a common saw: the teeth of the saw are set, that is, bent out of the plane of the saw, one tooth on one side, the next on the other: the outsides, *r*, (in fig. 3.) of the teeth are not filed to leave a surface perpendicular to the plane of the saw, but inclined to it, and in the same direction that each tooth so filed is bent in the setting: by this means the saw, when cutting, first takes away the wood at the two sides of the kerf, leaving an angular ridge in the middle of it, the use of which is to keep the saw steady in a right line, that it may not have so much tendency to get out of the straight in any place where the wood is harder at one side than on the other.

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In early periods, the trunks of trees were split with wedges into as many and as thin pieces as possible, and if it were necessary to have them still thinner, they were hewn on both sides to the proper size. This simple and wasteful manner of making boards has been still continued in some places to the present time. Peter the Great of Russia endeavoured to put a stop to it, by forbidding hewn deals to be transported on the river Neva. The saw, however, though so convenient and beneficial, has not been able to banish entirely the practice of splitting timber used in building, or in making furniture and utensils, for we do not speak here of fire-wood; and indeed it must be allowed, that this method is attended with peculiar advantages, which that of sawing can never possess. The wood-splitters perform their work more expeditiously than sawyers, and split timber is much stronger than that which has been sawn: for the fissure follows the grain of the wood, and leaves it whole; whereas the saw, which proceeds in the line chalked out for it, divides the fibres, and by these means lessens its cohesion and solidity. Split timber, indeed, turns out often crooked and warped; but in many purposes to which it is applied, this is not prejudicial; and these faults may sometimes be amended. As the fibres, however, retain their natural length and direction, thin boards, particularly, can be bent much better. This is a great advantage in making pipe-staves, or sieve-frames, which require still more art, and in forming various implements of the like kind.

The most beneficial and ingenious improvement of this instrument was, without doubt, the invention of saw-mills, which are driven either by water or by the wind. Mills of the first kind were erected so nearly as the fourth century in Germany, on the small river Roeur or Ruer: for though Ansonius speaks properly of water-mills for cutting stone, and not timber, it cannot be doubted that these were invented later than mills for manufacturing deals, or that both kinds were erected at the same time. The art, however, of cutting marble with a saw is very old. Pliny conjectures that it was invented at Caria; at least he knew no building incrusted with marble of greater antiquity than the palace of king Mausolus, at Halicarnassus. This edifice is celebrated by Vitruvius for the beauty of its marble; and Pliny gives an account of the different kinds of sand used for cutting it; for it is the sand properly, says he, and not the saw, which produces that effect. The latter presses down the former, and rubs it against the marble; and the coarser the sand is, the longer will be the time required to polish the marble which has been cut by it. Stones of the soap-rock kind, which are indeed softer than marble, and which would require less force than wood, were sawn at that period: but it appears that the far harder glassy kinds of stone were sawn then also; for we are told of the discovery of a building, which was incrusted with cut agate, cornelian, lapis lazuli, and amethysts. We have, however, found no account in any of the Greek or Roman writers of a mill for sawing wood; and as the writers of modern times speak of saw-mills as new and uncommon, it would seem that the oldest construction of them has been forgotten, or that some important improvement has made them appear entirely new.

Becher, in his history of inventions, says that saw-mills were invented in the 17th century. In this he erred, for when the infant Henry sent settlers to the island of Madeira, which was discovered in 1420, and caused European fruits of every kind to be carried thither, he ordered saw-mills to be erected also, for the purpose of sawing into deals the various species of excellent timber with which the island abounded, and which were afterwards transported to Portugal. About the year 1427, the city of Breslau had a saw-mill, which produced a yearly rent of three marks; and in 1490, the magistrates of Erfurt purchased a forest, in which they caused a saw-mill to be erected, and they rented another mill in the neighbourhood besides.

Norway, which is covered with forests, had the first saw-mill about the year 1530. This mode of manufacturing timber was called the new art; and because the exportation of deals was by these means increased, that circumstance gave occasion to the deal-tithe, introduced by Christian III. in the year 1545. Soon after the celebrated Henry Canzau caused the first mill of this kind to be built in Holstein. In 1552 there was a saw-mill at Joachimstal, which, as we are told, belonged to Jacob Geusen, mathematician. In the year 1555, the bishop of Ely, ambassador from Mary queen of England to the court of Rome, having seen a saw-mill in the neighbourhood of Lyons, the writer of his travels thought it worthy of a particular description. In the sixteenth century, however, there were mills with

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different saw-blades, by which a plank could be cut into several deals at the same time. The first saw-mill was erected in Holland at Saardam, in the year 1596; and the invention of it is ascribed to Cornelius Cornelissen. Perhaps he was the first person who built a saw-mill at that place, which is a village of great trade, and has still a great many saw-mills, though the number of them is becoming daily less; for within the last half century a hundred have been given up. The first mill of this kind in Sweden was erected in the year 1653. At present, that kingdom possesses the largest perhaps ever constructed in Europe, where a water-wheel, twelve feet broad, drives at the same time seventy-two saws.

In England, saw-mills had at first the same fate that printing had in Turkey, the ribbon-loom in the dominions of the church, and the crane at Strasburgh. When attempts were made to introduce them, they were violently opposed, because it was apprehended that the sawyers would be deprived by them of their means of getting a subsistence. For this reason, it was found necessary to abandon a saw-mill erected by a Dutchman near London, in 1663; and in the year 1700, when one Houghton laid before the nation the advantages of such a mill, he expressed his apprehension that it might excite the rage of the populace. What he dreaded was actually the case in 1767 or 1768, when an opulent timber-merchant, by the desire and approbation of the Society of Arts, caused a saw-mill, driven by wind, to be erected at Limehouse, under the direction of James Stanfield, who had learned, in Holland and Norway, the art of constructing and managing machines of that kind. A mob assembled, and pulled the mill to pieces; but the damage was made good by the nation, and some of the rioters were punished. A new mill was afterwards erected, which was suffered to work without molestation, and which gave occasion to the erection of others. It appears, however, that this was not the only mill of the kind then in Britain; for one driven also by wind had been built at Leith, in Scotland, some years before.

SAXIFRAGA, in botany, *saxifrage*, a genus of the Decandria Digynia class and order. Natural order of Succulentæ. Saxifragæ, Jussieu. Essential character: calyx five-parted, five-petalled; capsule two-beaked, one-celled, many-seeded. There are fifty species; of these we shall notice the S. granulata, or white saxifrage, which grows naturally in the meadows in many parts of England. The roots of this plant are like grains of corn, of a reddish colour without: there is a variety of this with double flowers, which is very ornamental. The leaves are tongue-shaped, gathered into heads, rounded at their points, and have cartilaginous and sawed borders. The stalk rises two feet and a half high, branching out near the ground, forming a natural pyramid to the top. The flowers have five white wedge-shaped petals, and ten stamina, placed circularly the length of the tube, terminated by roundish purple summits. When these plants are strong, they produce very large pyramids of flowers. S. umbrosa, commonly called London pride, or none-so-pretty, grows naturally on the Alps, and also in great plenty on a mountain of Ireland, called Mangerton, in the county of Kerry, in that island. The roots of this are perennial. S. oppositifolia grows naturally on the Alps, Pyrenees, and Helvetian mountains: it is also found pretty plentifully growing upon Ingleborough hill, in Yorkshire; Snowdon, in Wales; and some other places. It is a perennial plant, with stalks trailing upon the ground. The flowers are produced at the end of the branches, of a deep blue.

SCABIOSA, in botany, *scabius*, a genus of the Tetrandia Monogynia class and order. Natural order of Aggregatæ. Dipsaceæ, Jussieu. Essential character: calyx common, many-leaved; proper double superior; receptacle chaffy. There are forty-three species. S. arvensis, or meadow scabius, grows naturally in many places of Britain. The flowers are produced upon naked footstalks at the ends of the branches: they are of a purple colour, and have a faint odour. S. succisa, or devil's bit, grows on woods and moist places. This has a short tap-root, the end of which appears as if it was bitten or cut off, whence the plant has taken its name.

SCABRIDÆ, in botany, the name of the fifty-third order in Linnæus's Fragments of a Natural Method, consisting of plants with rough leaves. Among these are the ficus and morus, which yield by incision a milky juice. Another genus is the cannabis, or hemp, from the leaves of which, in the East Indies, an intoxicating liquor is prepared, and from the seeds is drawn an oil useful for lamps.

SCÆVOLA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Campanulaceæ, Jussieu. Essential character: corolla one-petalled,

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with the tube cloven longitudinally, the border five-cleft and lateral; drupe inferior, containing one two-celled nut. There are three species, natives of the East Indies.

SCHÆFFERA, in botany, a genus of the Dioecia Tetrandria class and order. Essential character: male, calyx four or five-leaved; corolla four-petalled, or none: female, calyx four or five-parted; corolla four-parted, or none; berry two-celled; seeds solitary. There are two species, viz. S. completa, and S. lateriflora, natives of the West Indies.

SCALE, a mathematical instrument, consisting of several lines drawn on wood, brass, silver, &c. and variously divided, according to the purposes it is intended to serve; whence it acquires various denominations, as the plain scale, diagonal scale, plotting scale, Gunter's scale, &c. See MATHEMATICAL INSTRUMENTS.

SCALE, *diagonal*, is projected thus: first draw eleven parallel lines at equal distances, the whole length of which being divided into a certain number of equal parts, according to the length of the scale, by perpendicular parallels, let the first division be again subdivided into ten equal parts, both above and below; then drawing the oblique lines from the first perpendicular below to the first subdivision above, and from the first subdivision below to the second subdivision above, &c. the first space shall thereby be exactly divided into one hundred equal parts; for as each of these subdivisions is one tenth part of the whole first space or division, so each parallel above it is one tenth of such subdivision, and consequently one hundredth part of the whole first space; and if there be ten of the larger divisions, one thousandth part of the whole scale. If therefore the larger divisions be accounted units, the first subdivisions will be tenth parts of an unit; and the second subdivisions, marked by the diagonals on the parallels, hundredth parts of an unit. Again, if the larger divisions be reckoned tens, the first subdivisions will be units, and the second subdivisions tenth parts; and if the larger divisions be accounted hundredths, the first subdivisions will be tens, and the second units: and so on.

SCALE, *Gunter's*, an instrument, so called from Mr. Gunter, its inventor, is generally made of box; there are two sorts, the long Gunter, and the sliding Gunter, having both the same lines, but differently used, the former with the compasses, the latter by sliding. The lines now generally delineated on those instruments are the following, *viz.* a line of numbers, of sines, tangents, versed sines, sine of the rhumb, tangent of the rhumb, meridional parts, and equal parts; which are constructed after the following manner:

The line of numbers is no other than the logarithmic scale of proportionals, wherein the distance between each division is equal to the number of mean proportionals contained between the two terms, in such parts as the distance between 1 and 10 is 1000, &c. equal the logarithm of that number. Hence it follows, that if the number of equal parts expressed by the logarithm of any number be taken from the same scale of equal parts, and set off from 1 on the line of numbers, the division will represent the number answering to that logarithm. Thus, if you take .954, &c. (the logarithms of 9) of the same parts, and set it off from 1 towards 10, you will have the division standing against the number 9. In like manner, if you set off .903, &c. .845, &c. .778, &c. (the logarithms of 8, 7, 6) of the same equal parts from 1 towards 10, you will have the divisions answering to the numbers 8, 7, 6. After the same manner may the whole line be constructed.

The line of numbers being thus constructed, if the numbers answering to the natural sines and tangents of any arch, in such parts as the radius is 10,000, &c. be found upon the line of numbers, right against them will stand the respective divisions answering to the respective arches, or, which is the same thing, if the distance between the centre and that division of the line of numbers, which expresses the number answering to the natural sine or tangent of any arch, be set off on its respective line from its centre towards the left hand, it will give the point answering to the sine or tangent of that arch: thus the natural sine of 30 degrees being 5,000, &c. if the distance between the centre of the line of numbers (which in this case is equal to 10,000, &c. equal the radius) and the division, on the same line representing 5,000, &c. be set off from the centre, or 90 degrees, on the line of sines, towards the left hand, it will give the point answering to the sine of 30 degrees. And after the same manner may the whole line of sines, tangents, and versed sines, be divided.

The line of sines, tangents, and versed sines, being thus constructed, the line sine of the rhumb, and tangent of the rhumb, are easily divided; for if the de-

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grees and minutes, answering to the angle which every rhumb makes with the meridian, be transferred from its respective line to that which is to be divided, we shall have the several points required: thus, if the distance between the radius or centre and sine of 45 degrees equals the fourth rhumb, be set off upon the line sine of the rhumb, we shall have the point answering to the sine of the fourth rhumb; and after the same manner may both these lines be constructed. The line of meridional parts is constructed from the table of meridional parts, in the same manner as the line of numbers is from the logarithms.

The lines being thus constructed, all problems relating to arithmetic, trigonometry, and their depending sciences, may be solved by the extent of the compasses only; and, as all questions are reducible to proportions, the general rule is, to extend the compasses from the first term to the second, and the same extent of the compasses will reach from the third to the fourth; which fourth term must be so continued as to be the thing required, which a little practice will render easy.

Scale, *scala*, in music, is a denomination given to the arrangement of the six syllables invented by Guido Aretine, *ut, re, mi, fa, sol, la*, called also gamut. It bears the name scale (*q. d.* ladder) because it represents a kind of ladder, by means whereof the voice rises to acute, or descends to grave; each of six syllables being, as it were, one step of the ladder. Scale is also used for a series of sounds rising or falling towards acuteness or gravity, from any given pitch of tune, to the greatest distance that is fit or practicable, through such intermediate degrees as make the succession most agreeable and perfect, and in which we have all the harmonical intervals most commodiously divided.

Scales *of fish*, generally possess a silvery whiteness, and are composed of different laminæ. In many of their properties they resemble horn. By long boiling in water they become soft, and when they are kept for some hours in nitric acid, they are converted into a transparent membranous substance. By saturating the acid with ammonia, a precipitate is formed, which is phosphate of lime. The constituent parts of scales, therefore, are membrane and phosphate of lime.

SCALENE, or Scalenous triangle, in geometry, a triangle whose sides and angles are unequal.

SCAMMONY, in the Materia Medica, is a concreted vegetable juice of a plant of the same name, partly of the resin and partly of the gum kind, of which there are two sorts, distinguished by the names of the places from whence they are brought. The Aleppo scammony is of a spongy texture, light and friable; it is of a faint disagreeable smell, and its taste is bitterish, very nauseous, and acrimonious. The Smyrna scammony is considerably hard and heavy, of a black colour, and of a much stronger smell and taste than the former, otherwise it much resembles it.

SCANDALUM *magnatum*, is the special name of a statute, and also of a wrong done to any high personage of the land, as prelates, dukes, marquises, earls, barons, and other nobles; and also the chancellor, treasurer, clerk of the privy seal, steward of the house, justice of one bench or other, and other great officers of the realm, by false news, or horrible or false messages, whereby debates and discord, between them and the commons, or any scandal to their persons, might arise. 2 Richard II. c. 5. This statute has given a name to a writ, granted to recover damages thereupon.

It is now clearly agreed, that though there be no express words in the statute which give an action, yet the party injured may maintain one on this principle of law, that when a statute prohibits the doing of a thing, which, if done, might be prejudicial to another, in such case he may have an action on that very statute for his damages.

SCANDIX, in botany, *chervil*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ or Umbelliferæ. Essential character: florets of the disk most commonly male; corolla radiate; petals emarginate; fruit awl-shaped. There are eleven species. The most remarkable is S. odorata, with angular furrowed seeds. It is a native of Germany, and has a very thick perennial root, composed of many fibres, of a sweet aromatic taste, like aniseed, from which come forth many large leaves that branch out somewhat like those of fern, whence it is named sweet fern.

SCANNING, in poetry, the measuring of a verse by feet, in order to see whether or no the quantities be duly observed.

The term is chiefly used in regard to the Greek and Latin verses. Thus an

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hexameter verse is scanned, by resolving it into six feet; a pentameter, by resolving it into five feet, &c.

SCANTLING, in building, is particularly applied to the dimensions of any piece of timber, with regard to its breadth and thickness.

SCAPEMENT, a general term for the manner of communicating the impulse of the wheels to the pendulum of a clock. Common scapements consist of the swing wheel and pallets only. See Horology, &c.

SCAPOLITE, in mineralogy, a species of the Flint genus, is of a greyish white colour, passing into greenish grey; it occurs massive, but most commonly crystallized in long, thin, often acicular prisms. Externally it is glistening; internally it is shining and glistening; its lustre is between resinous and pearly. It is brittle and frangible. Specific gravity about 3.7. Before the blow-pipe it intumesces, and melts into shining white enamel. It is found in the iron-stone mines in Norway. Its crystals are sometimes mixed with mica, calc-spar, and felspar. It is composed of

Silica	48
Alumina	30
Lime	14
Oxide of iron	1
Water	2
	95
Loss	5
	100

SCARABÆUS, in natural history, the *beetle*, a genus of insects of the order Coleoptera. Generic character: antennæ clavate, the club lamellate; feelers four; fore-shanks generally toothed. In this genus there are several hundred species, in four divisions, which are distinguished by the form of their feelers.

S. Hercules, or Hercules beetle, is the most remarkable species, as well in size as in beauty. It is five or six inches long; the wing-shells are of a smooth surface, of a bluish-grey colour, marked with round, deep-black spots, of different sizes; from the upper part of the thorax proceeds a horn of great length in proportion to the body; it is sharp at the tip, and is furnished, throughout its whole length with a fine, short, velvet-like pile, of a brownish-orange colour; from the front of the head also proceeds a strong horn, like the other, but not furnished with any pile. This insect is found in several parts of South America, where great numbers are said to be sometimes seen on the mammee-tree, rasping off the rind of the slender branches, by working nimbly round them with the horns, till they cause the juice to flow, which they drink to intoxication, and in this state fall senseless from the tree. This fact has been controverted by the learned Fabricius.

In this country, the S. melolontha, or cock-chaffer, is very common. The larva inhabits ploughed lands, and feeding on the roots of corn; and the complete insect makes its appearance during the middle and the decline of summer. This insect sometimes appears in such prodigious numbers, as almost to strip the trees of their foliage, and to produce mischiefs nearly approaching to those of the locust-tribe; they are thus described in the "Philosophical Transactions" for the year 1697, by Mr. Molineux. "These insects were first noticed in this kingdom in 1688. They appeared on the south-west coast of Galway, brought thither by a south-west wind, one of the most common, I might almost say, trade-winds of this country. From hence they penetrated into the inland parts towards Heddford, about twelve miles north of the town of Galway: here and there, in the adjacent country, multitudes of them appeared among the trees and hedges, in the day time, hanging by the boughs in clusters, like bees when they swarm. In this posture they continued, with little or no motion, during the heat of the sun; but towards evening or sun-set, they would all disperse and fly about, with a strange humming noise, like the beating of distant drums, and in such vast numbers, that they darkened the air for the space of two or three miles square. Persons travelling on the roads, or abroad in the fields, found it very uneasy to make their way through them, they would so beat and knock themselves against their faces in their flight, and with such a force as to make the place smart, and leave a slight mark behind them. In a short time after their coming, they had so entirely eaten up and destroyed all the leaves of the trees, for some miles round, that the whole country, though in the middle of summer, was left as bare as in the depth of winter: and the noise they made in gnawing the leaves, made a sound much resembling the sawing of timber. They also came into the gardens, and destroyed

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the buds, blossoms, and leaves of all the fruit-trees, so that they were left perfectly naked, nay many, that were more delicate than the rest, lost their sap, as well as leaves, and quite withered away, so that they never recovered again. Their multitudes spread so exceedingly, that they infested houses, and became extremely offensive and troublesome. Their numerous young, hatched from the eggs which they had lodged under ground, near the surface of the earth, did still more harm in that close retirement than all the flying swarms of their parents had done abroad; for this destructive brood, lying under ground, eat up the roots of corn and grass, and thus consumed the support both of man and beast. This plague was happily checked several ways. High winds, and wet misling weather, destroyed many millions of them in a day; and when this constitution of the air prevailed, they were so enfeebled that they would let go their hold, and drop to the ground, from the branches, and so little a fall as this was sufficient quite to disable, and sometimes perfectly kill them. Nay, it was observable, that even when they were most vigorous, a slight blow would for some time stun them, if not deprive them of life. During these unfavourable seasons of the weather, the swine and poultry of the country would watch under the trees for their falling, and feed and fatten upon them; and even the poorer sort of the country people, the country then labouring under a scarcity of provision, had a way of dressing them, and lived upon them as food. In a little time it was found, that smoke was another thing very offensive to them, and by burning heath, fern, &c. the gardens were secured, or, if the insects had already entered, they were thus driven out again. Towards the latter end of summer, they returned of themselves, and so totally disappeared, that in a few days you could not see one left. A year or two ago, all along the south-west coast of the county of Galway, for some miles together, there were found dead on the shore such infinite multitudes of them, and in such vast heaps, that, by a moderate estimate, it was computed there could not be less than forty or fifty horse-loads in all; which was a new colony, or a supernumerary swarm, from the same place whence the first stock came in 1688, driven by the wind from their native land, which I conclude to be Normandy, or Brittany, in France, it being a country much infested with this insect, and from whence England heretofore has been pestered in a similar manner with swarms of this vermin; but these, meeting with a contrary wind before they could land, were stopped, and, tired with the voyage, were all driven into the sea, which, by the motion of its waves and tides, cast their floating bodies in heaps on the shore. It is observed that they seldom keep above a year together in a place, and their usual stages, or marches, are computed to be about six miles in a year. Hitherto their progress has been westerly, following the course of that wind, which blows most commonly in this country."

The larva of this insect is eagerly sought after and devoured by swine, bats, crows, and poultry: it is said to be two or three years in passing from its first form into that of the perfect insect. The eggs are laid in small detached heaps, beneath the surface of some clod, and the young, when first hatched, are scarcely more than the eighth of an inch in length, gradually advancing in their growth, and occasionally shifting their skins, till they arrive at the length of nearly two inches. At this period they begin to prepare for their change into a chrysalis or pupa, selecting for the purpose some small clod of earth, in which they form a cavity, and after a certain time, divest themselves of their last skin, and immediately appear in the pupa state. In this they continue till the succeeding summer, when the beetle emerges from its retirement, and commits its depredations on the leaves of trees, breeds, and deposits its eggs in a favourable situation, after which its life is of very short duration.—If the larva appear in autumn in considerable quantities, they are said to prognosticate epidemic disorders.

A species of great beauty is the S. auratus, or golden beetle, about the size of the common or black garden beetle: the colour is most brilliant, varnished, and of a golden-green. This is a fine object for the magnifying glass. It is not very uncommon during the hottest parts of summer, frequenting various plants and flowers; its larva is commonly found in the hollows of old trees, or among the loose dry soil at their roots, and sometimes in the earth of ant-hills.

Mr. Donovan has described, among his English insects, the S. stercorarius, or clock-beetle, which flies about in an evening, in a circular direction, with a loud buzzing noise, and is said to foretel a fine day. It was consecrated by the Egyp-

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tians to the sun; is infested with the acarus and ichneumon; the body is often coloured with a bluish or greenish gloss, sometimes brassy beneath; shells frequently dull, rufous.

SCARIFICATION, in surgery, the operation of making several incisions in the skin by means of lancets, or other instruments, particularly the cupping instrument.

SCARP, in fortification, is the interior talus, or slope of the ditch next the place, at the foot of the rampart.

Scarp, in heraldry, the scarf which military commanders wear for ornament. It is borne somewhat like a battoon sinister, but is broader than it, and is continued out to the edges of the field; whereas the battoon is cut off at each end.

SCARUS, in natural history, a genus of fishes of the order Thoracici. Generic character: instead of teeth, strong bony processes, crenated at the edges: gill-membrane five-rayed; lateral line mostly branched. There are eight species; S. rivulatus, is found in the Red Sea, about the length of three feet. It feeds on herbs, and is used for food; but any puncture, or laceration, by the dorsal spine of this fish, is said to be attended with extraordinary pain and inflammation. The other species are mostly inhabitants of the same sea.

SCAVAGE, a toll or custom anciently exacted by mayors, sheriffs, and bailiffs, of cities and towns-corporate, and of merchant-strangers, for wares exposed and offered to sale within their liberties; which was prohibited by 19 Henry VII. But the City of London still retains this custom.

SCENOGRAPHY, in perspective, the representation of a body on a perspective plane; or, a description thereof in all its dimensions, such as it appears to the eye. The ichnography of a building, &c. represents its plan, or ground-work; the orthography is a view of the front, or one of its sides; and the scenography is a view of the whole building, front, sides, height, and all, raised on the geometrical plan

SCEPTRE, in astronomy, one of the six new constellations of the southern hemisphere, consisting of seventeen stars.

SCHAALSTONE, in mineralogy, a species of the calc genus, is of a greyish white colour, with varieties; it occurs massive, and the lustre of its principal fracture is shining and nearly pearly. It is translucent, brittle, easily frangible, and not very heavy. It has hitherto been found only in the Bannat of Temeswar, and is accompanied by ores of copper. It is composed of lime and silica.

SCHAUM *earth*, or Foaming earth, in mineralogy, a species of the calc genus, is of a very light yellowish, nearly silver white colour, approaching sometimes to greyish-white. It occurs massive and disseminated, sometimes loose, and composed of fine scaly particles, or intermediate between friable and loose. Its lustre is between shining and glistening. It is soft, friable, fine, but not greasy. With acids it effervesces, and is dissolved in them. By analysis it is found to be composed of lime and carbonic acid. It is nearly allied to slate-spar, and is found in the forest of Thuringia, also in the north of Ireland.

SCHEFFLERA, in botany, so named in honour of Scheffer, physician and botanist at Dantzic, a genus of the Pentandria Decagynia class and order. Essential character: calyx five-toothed; corolla five-petalled; capsule eight or ten celled; seeds solitary, semicircular. There is only one species, viz. S. digitata, a native of New Zealand.

SCHEME, a draught or representation of any astronomical or geometrical figure or problem, by lines sensible to the eye; or of the celestial bodies in their proper places for any given moment. It is otherwise called a diagram.

SCHEUCHZERIA, in botany, so named in memory of John Scheuchzer, professor of physic at Zurich, a genus of the Hexandria Trigynia class and order. Natural order of Tripetaloideæ. Junci, Jussieu. Essential character: calyx six-parted; corolla none; styles none; capsule three, inflated, one-seeded There is but one species, *viz.* S. palustris, a native of the North of Europe.

SCHIEFER *spar*, one of the species of carbonate of lime. It is of a grey colour, passing to red, and even in some specimens to green. It is found massive,; the texture is foliated; it is brittle; feels unctuous; and may be scratched with the nail. Specific gravity 2.7. It is composed of carbonate of lime, with some silica, and oxide of iron.

SCHILLER *stone*, in mineralogy, a species of the talc genus, of an olive green; usually disseminated and massive, probably also crystallized. Lustre shining, passing into semi-metallic: fracture perfectly foliate. Soft, slightly brittle, easily frangible, and not particularly heavy. It occurs imbedded in serpentine, and is frequently accompanied with mica. It is found in Saxony, Cornwall and Scotland.

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SCHINUS, in botany, a genus of the Dioecia Decandria class and order. Natural order of Dumosæ. Terebintaceæ, Jussieu. Essential character: calyx five-parted; petals five: female, berry three-celled. There are two species, *viz* S. molle, Peruvian mastich tree, and S. areira, Brazilian mastich tree.

SCHISTUS, in mineralogy, a name given to several different kinds of stones, but more especially to some of the argillaceous kind: as, 1. The bluish purple schistus, S. tegularis, or common roof-slate: this is so soft that it may be slightly scraped with the nail, and is of a very brittle lamellated texture: of the specific gravity of 2 8. It is fusible *per se* in a strong heat, and runs into a black scoria. By a chemical analysis it is found to consist of

Argillaceous earth	26
Silex	46
Magnesia	8
Lime	4
Iron	14
	98

The dark blue slate, or S. scriptorius, contains more magnesia and less iron than the common purple schistus, and effervesces more briskly with acids. Its specific gravity is 2 7. 2. The pyritaceous schistus is of a grey colour, brown, blue, or black; and capable of more or less decomposition by exposure to the air, according to the quantity of pyritous matter it contains, and the state of the iron in it. The aluminous schistus belongs to this species. 3. The bituminous schistus is generally black, and of a lamellated texture, of various degrees of hardness, not giving fire with steel, but emitting a strong smell when heated, and sometimes without being heated.

SCHMELZSTEIN, in mineralogy, a substance, hitherto only found on the Pyrenees, where it is imbedded in steatite: it is of a greyish white, passing through the different shades to rose red; it is shining, and its lustre is vitreous; it is easily frangible. Specific gravity 2 6. It swells before the blow-pipe. The constituent parts are

Silica	60
Alumina	24
Calcareous earth	10
Water	2
	96
Loss	4
	100

SCHMIDELIA, in botany, so named in honour of Casimir Christopher Schmidel, professor of botany at Erlang, a genus of the Octandria Digynia class and order. Natural order of Sapindi, Jussieu. Essential character: calyx two-leaved; corolla four-petalled; germs pedicelled, longer than the flower. There is only one species, viz. S. racemosa, a native of the East Indies.

SCHOENUS, in botany, *bog rush*, a genus of the Triandria Monogynia class and order. Natural order of Calamariæ. Cyperoideæ, Jussieu. Essential character; glumes chaffy, heaped, the outer ones barren; corolla none; seed one, roundish among the glumes. There are forty-one species.

SCHOEPFIA, in botany, so named in honour of Johan David Schoepf, a genus of the Pentandria Monogynia class and order Natural order of Aggregatæ. Caprifolia, Jussieu Essential character: calyx double, outer bifid, inferior; inner superior, quite entire; corolla bell-shaped; stigma capitate; drupe one-seeded. There is but one species, *viz.* S. Americana, a native of Santa Cruz and Montserrat.

SCHOLIAST, or COMMENTATOR, a grammarian, who writes scholia, that is, notes, glosses, &c. upon ancient authors, who have written in the learned languages. See the next article.

SCHOLIUM, a note, annotation, or remark, occasionally made on some passage, proposition, or the like. This term is much used in geometry, and other parts of mathematics, where, after demonstrating a proposition, it is customary to point out how it might be done some other way, or to give some advice, or precaution, in order to prevent mistakes, or add some particular use, or application thereof.

SCHORL, in mineralogy, a species of the Flint genus, which is divided by Werner into two sub-species, *viz.* the common schorl and the tourmaline. The common schorl is black. It occurs often massive and disseminated, seldom in rolled pieces, and frequently crystallized The crystals are mostly acicular; fragments, when broken, indeterminably angular; it very rarely presents coarse and small grained distinct concretions; sometimes it occurs in very thin, and but rarely in thick, straight and prismatic distinct concretions. It is opaque, and but little translucent on the edges, when it passes to the tourmaline. It gives a grey streak; is hard, and very easily frangible. Specific gravity from 3.09 to 3.21. It melts before

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the blow-pipe, without addition, into a blackish slag. Melted with borax, it forms a greenish-coloured glass. It is composed of

Silica	33.33
Alumina	40.83
Iron	20.41
Manganese	3.33
	97.90
Loss	2.10
	100

By heating, it exhibits positive electricity at one end, and negative at the other: as it cools, these electricities are reversed. It occurs in primitive rocks, chiefly in quartz and granite; with the former, it constitutes a peculiar mountain rock. It is found on many parts of the continent, and in Scotland. It differs from tourmaline in colour, degree of lustre, fracture, transparency, and distinct concretions; also in geognostic situations: tourmaline occurs almost always imbedded, and in single crystals; but schorl is aggregated, and occurs in beds.

Tourmaline, called also electricus turmalin, is of a green or brown colour, passing into others, even to the indigo blue. The colours are mostly dark. It occurs very seldom massive, oftener in rolled pieces, but most frequently crystallized. The crystals are generally three-sided prisms; they are usually imbedded; the internal lustre is splendent and vitreous. It is hard, and easily frangible. Specific gravity from 3 08 to 3.36. Before the blow-pipe it melts into a greyish-white vesicular enamel. It was found in Ceylon and the Brazils, in the 16th century; and since that in Madagascar and Ava, in many parts of the European continent, and in Scotland. Two specimens have been analyzed by Bergmann and Vauquelin, the former was brought from Ceylon, the latter from Brazil.

	Tourmaline of Ceylon.	Of Brazil.
Silica	37.0	40.0
Alumina	39.0	39.0
Lime	15.0	3 84
Oxide of iron	9.0	12.50
—— manganese		2.00
	100.0	97.34
	Loss	2.66
		100.00

Tourmaline has been long celebrated for its electrical effects, which are exhibited by friction, and also by heating: but if it is made very hot, as beyond 200° of Fahrenheit, it is deprived of its electrical properties. The more transparent the tourmaline, the stronger its electrical properties. It is sometimes cut and polished, and worn as a jewel; but on account of its want of transparency it is not very highly esteemed. The green coloured tourmaline has been described as the emerald; the blue, as the sapphire; and the crimson-red variety, first found in Siberia, and since in Ava and Ceylon, has been called the daurite, siberite, and rubellite. Mr. Greville is in possession of the most magnificent specimen of the red variety; it is valued, on account of its beauty and rarity, at 1000*l*.

SCHOTIA, in botany, so named from Richard Vander Schot, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx five-cleft; petals five, inserted into the calyx, closed by the sides lying over each other; legume pedicelled. There is but one species, *viz.* S. speciosa, lentiscus-leaved schotia. It is a native of Senegal and the Cape of Good Hope.

SCHRADERA, in botany, so named in honour of Henr Adolph Schrader, a genus of the Hexandria Monogynia class and order. Essential character: calyx a superior rim, quite entire: corolla five or six cleft; stigmas two; berry one-celled, many-seeded. There are two species, *viz.* S capitata and S. cephalotes.

SCHREBERA, in botany, a genus of the Diandria Monogynia class and order. Essential character: calyx two-lipped; corolla from five to seven-cleft; capsule pear-shaped, two-celled, two-valved; seeds from eight to ten, membranaceous winged. There is but one species, *viz.* S. swietenioides.

SCHWALBEA, in botany, so named in honour of Schwalbe, a physician, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx four-cleft, the upper lobe very small; the lowest very large and emarginate. There is but one species, *viz.* S. Americana.

SCHWENKFELDIA, in botany, so named in memory of Caspar Schenckfelt, a Silesian physician, a genus of the Pentandria Monogynia class and order. Natural order of Rubiaceæ. Essential character: involucre four-leaved; corolla

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funnel-form; stigmas five; berry five-celled, many-seeded. There are three species

SCHWENKIA, in botany, so named from Martin Wilhelm Schwencke, professor of botany at the Hague, a genus of the Diandria Monogynia class and order. Natural order of Luridæ. Scrophulariæ, Jussieu. Essential character: corolla almost equal, with the throat plaited and glandular; stamens three, barren; capsule two-celled, many-seeded. There is only one species, *viz.* S. Americana, Guinea Schwenkia.

SCIÆNA, in natural history, a genus of fishes of the order Thoracici. Generic character: head covered with scales; gill-membrane generally with about six rays; two dorsal fins placed in a furrow, into which they are often withdrawn. There are twenty-nine species, the principal of which is the S. cirrosa, or bearded sciæna, which inhabits the European and American seas, and is from one to two feet in length. It was known to the ancients, and esteemed by them for the table. It is of a pale yellow colour, striped longitudinally with dusky-blue. Its tail slightly lunated, and it has under its chin a short fleshy beard.

SCIAGRAPHY, the profile or vertical section of a building, used to show the inside of it. The same term is used in astronomy, for the art of finding the hour of the day, or night, by the shadow of the sun, moon, stars, &c.

SCIENCE, in philosophy, denotes any doctrine deduced from self-evident and certain principles, by a regular demonstration. Sciences may be properly divided as follows: 1. The knowledge of things, their constitutions, properties, and operations; this, in a little more enlarged sense of the word, may be called φυσικη, or natural philosophy; the end of which is speculative truth. 2. The skill of rightly applying these powers, πρακτικη; the most considerable under this head is ethics, which is the seeking out those rules and measures of human actions that lead to happiness, and the means to practise them; and the next is mechanics, or the application of the powers of natural agents to the uses of life. See PHILOSOPHY, *moral.* 3. The doctrine of signs, σημειωτικη; the most usual of which being words, it is aptly enough termed logic. See LOGIC.

This, says Mr. Locke, seems to be the most general, as well as natural, division of the objects of our understanding. For a man can employ his thoughts about nothing but either the contemplation of things themselves, for the discovery of truth, or about the things in his own power, which are his actions, for the attainment of his own ends; or the signs the mind makes use of, both in the one and the other, and the right ordering of them for its clearer understanding All which three, *viz.* things, as they are in themselves knowable; actions, as they depend on us in order to happiness; and the right use of signs, in order to knowledge, being *toto cælo* different, they seem to be the three great provinces of the intellectual world, wholly separate and distinct one from another

SCILLA, in botany, *squill*, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Asphodeli, Jussieu. Essential character: corolla six-petalled, spreading, deciduous; filaments filiform. There are twenty-two species. The most remarkable is S. maritima, or sea onion, whose roots are used in medicine. Of this there are two sorts, one with a red, and the other with a white root: which are supposed to be accidental varieties, but the white are generally preferred for medicinal use. The roots are large, somewhat oval-shaped, composed of many coats lying over each other like onions; and at the bottom come out several fibres. From the middle of the root rise several shining leaves, which continue green all the winter, and decay in the spring. Then the flower-stalk comes out, which rises two feet high, and is naked half-way, terminating in a pyramidal thyrse of flowers, which are white, composed of six petals, and spread open like the points of a star. This grows naturally on the sea-shores, and in the ditches where the salt water naturally flows with the tide, in most of the warm parts of Europe, so cannot be propagated in gardens; the frost in winter always destroying the roots, and for want of salt water they do not thrive in summer. The root is very nauseous to the taste, intensely bitter, and so acrimonious, that it ulcerates the skin if much handled.

SCIOPTIC, or SCIOPTRIC *ball*, a sphere, or globe of wood, with a circular hole or perforation, wherein a lens is placed. It is so fitted that, like the eye of an animal, it may be turned round every way, to be used in making experiments of the darkened room.

SCIRPUS, in botany, *club rush*, a genus of the Triandria Monogynia class and order. Natural order of Calamariæ.

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Cyperoideæ. Jussieu. Essential character: glumes chaffy, imbricate every way: corolla none; seed one, beardless. There are sixty-nine species.

SCIRE *facias*, is a judicial writ, and properly lies after a year and a day after judgment given; whereby the sheriff is commanded to summon or give notice to the defendant, that he appear and show cause why the plaintiff should not have execution. A scire facias is deemed a judicial writ, and founded on some matter of record, as judgment recognizances, and letters patent, on which it lies, to enforce the execution of them, or to vacate or set them aside; and if execution is not taken out within a year, it is necessary to revive the judgment by scire facias. But if execution has isued within that time, a further writ of execution may be had without a scire facias. This writ is so far in nature of an original, that the defendant may plead to it, and it is in that respect considered as an action. Wherefore a release of all actions, or a release of all executions, is a good bar to a scire facias.

SCIRRHUS, in surgery and medicine, a hard tumour of any part of the body, void of pain, arising from the inspissation and induration of the fluids contained in a gland, though it may appear in any other part, especially in the fat, being one of the ways wherein an inflammation terminates. Lee SURGERY.

SCITAMINEÆ, in botany, the name of the eighth order in Linnæus's Fragments of a Natural Method, consisting of beautiful exotic plants, some of which, as the banana, furnish exquisite fruits, and others have a fine aromatic scent; among these are the amomum, or ginger; the canna, Indian flowering reed; and musa, the banana, or plantain tree. The plants of this order are all natives of very warm countries; they grow to great heights, but they are only perennial at the roots. Some of these plants are cultivated in high perfection at the botanical garden at Liverpool.

SCIURIS, in botany a genus of the Diandria Monogynia class and order. Essential character: corolla unequal, with the upper lip trifid, the lower bifid and shorter; stamina five, but three barren; capsule five, united, one-celled, one-seeded. There is only one species, *viz.* S. aromatica, found in the woods of Guiana.

SCIURUS, the *squirrel*, in natural history, a genus of Mammalia, of the order Glires. Generic character; two fore-teeth in the upper jaw wedge-formed, in the lower sharp; five grinders in each side of the upper-jaw, and four in each of the lower; clavicles in the skeleton; tail spreading towards each side; long whiskers. These animals live principally on seeds and fruits. They are extremely active and nimble, climbing trees with great rapidity, and bounding from one to another with a spring truly astonishing. Some are supplied with membranes, which enable them to extend this leap into something approximating to a short flight. Some are subterraneous, and others build in trees. They are sprightly, elegant, and interesting.

S. maximus, or the great squirrel, is the largest known species, being equal in size to a cat. It is found in the East Indies, where it pierces the cocoa for the sake of the liquor, to which it is extremely attached. It is easily tamed.

S. vulgaris, or the common squirrel, abounds almost throughout Europe, and in the temperate climates of Asia. Its length is about seven inches to the tail, which measures about eight. During the summer's day, it generally remains in its nest, appearing to be annoyed by the heat; but at night it is full of alertness and vivacity, and devoted to excursion and repast. It constructs its nest generally in the fork of two branches of trees, and with particular precaution, with respect to dryness, warmth, and cleanliness. The young are produced sometimes about the beginning of summer, in general about the middle of it, and are three or four in number. Its food consists of various nuts and fruits, of which it stores considerable quantities for its winter consumption; it is fond also of certain species of fungi. In confinement it will take a vast variety of vegetable substances; but appears to prefer sugar to every other nourishment. See Mammalia, Plate XVIII. fig. 1.

S. cinereus, or the grey squirrel, is peculiar to North America, and is about the size of a half-grown rabbit. It resembles the former in its shape and manners. These animals have occasionally committed extreme ravages in some of the states of North America, in the cultivated lands; and to reduce their numbers, the legislature proclaimed a reward for their destruction. In the year 1750, a sum of no less than eight thousand pounds was distributed in premiums, to persons who had been engaged in killing them, and who must have destroyed between six and seven hundred thousand. It is not easily destroyed by the gun, on account

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of the perpetual versatility of its movements, and some of the best marksmen are often baffled by this extreme agility. It is easily familiarized, and appears susceptible of affection and gratitude to its benefactors.

The S. variegatus, or varied squirrel, is nearly twice the size of the last, and differs also in habits, as it resides in holes under the roots of trees, where it produces its young, and, like the rest of the genus, accumulates its stores It is a native of Mexico.

S. striatus, or the striped squirrel, is met with in the north of Asia and America, is subterraneous in its habitation, like the last, and is also addicted to hoarding, for winter, nuts and grain. It is distinguished, however, from every other species, by being provided with bags or pouches attached to its cheeks, in which, for the convenience of carriage, it can deposit large quantities of food, to take home with it after having swallowed a full meal. These squirrels abound in Siberia, amidst the woods of maple and fir, at the roots of which they make their burrows. They never mount trees, but when they have no other means of escape from an enemy, yet then they climb them with great celerity. They are very discriminating in their selection of food, and have been seen frequently to exchange cargoes contained in their pouches for a species of food which they casually and unexpectedly met with, and which they happened to prefer to the former. They retain in captivity much of their native wildness, and appear to evince no feelings of regard to their protectors.

S. volans, or the common flying squirrel, is the only one of that description in Europe, and is found there only in the coldest climates. In the north of Asia it occurs more frequently. Its colour above is a white grey, and beneath a perfect white. It is about six inches in length to the tail. It resides generally in hollow trees near the top, is solitary in its habits, associating even in pairs only in the spring. It feeds principally on the catkins of the birch, and in winter secludes itself in its nest, occasionally quitting it in fine weather. By means of an expansile furry membrane, reaching from the fore feet to the hind ones, these animals are enabled to spring or fly to the distance of thirty or forty yards. Climbing nearly to the top of one tree, it directs its movements always downwards, and by spreading this membrane as widely as possible, with its fore feet extremely distant from each other, presents such a surface to the air beneath, as gives it considerable buoyancy, and converts its elastic bounds into a species of flight. The membrane is also highly serviceable in cherishing the young ones, which are produced usually in May, and about three at a birth. See Mammalia, Plate XVIII. fig. 4.

S. petaurista, or the sailing squirrel, is an inhabitant of Java and the Indian Islands, and can spring to an immense distance from tree to tree, by means of a membrane similar to that of the preceding, which is extremely thin in the middle, and thicker towards the extremities. This is the largest of all the flying squirrels, and is eighteen inches long, exclusively of the tail. For the Barbary squirrel and the black squirrel, see Mammalia, Plate XVIII, fig. 2. and 3.

SCLERANTHUS, in botany, *knawel*, a genus of the Decandria Digynia class and order Natural order of Caryophillei. Portulaceæ, Jussieu. Essential character: calyx one-leafed, inferior; corolla none; seeds two, inclosed in the calyx. There are three species.

SCLERIA, in botany; a genus of the Monoecia Triandria class and order. Essential character; male, calyx glume from two to six-valved, many-flowered, awnless; female, calyx from two to six-valved, one-flowered, awnless; stigmas one to three; seed nut subglobular, somewhat bony, coloured. There are nine species.

SCLEROCARPUS, in botany, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx six-leaved, three exterior larger, like the leaves, three interior smaller, like scales, alternate; pappus none; receptacle chaffy. There is only one species, *viz.* S. Africanus, a native of the Cape of Good Hope.

SCLEROTICA, in anatomy, one of the tunics or coats of the eye; it is hard, opaque and extended from the cornea to the optic nerve; its forepart is transparent and is called the cornea.

SCOLEX, in natural history, a genus of the Vermes Intestina class and order: body gelatinous, variously shaped, broadish on the fore-part and pointed behind; sometimes linear and long, sometimes wrinkled and short, round, flexuous, or depressed: head protrusile, and retractile. Two species only are mentioned, *viz.* the pleuronectidis and lophii; the former is found in the intestinal mucus of

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the turbot, sole, plaise, gwiniard, and the lump fish, seldom visible to the naked eye. The other, as its name denotes, is discovered in the intestinal mucus of the lophus piscatorius: the body is minute, and hardly visible to the naked eye.

SCOLIA, in natural history, a genus of insects of the order Hymenoptera: mouth with a curved sharp mandible, crenate within; jaw compressed, projecting, entire and horny; tongue inflected, trifid, very short; lip projecting, membranaceous at the tip and entire; four feelers, equal and filiform, in the middle of the lip; antennæ thick, filiform, the first joint longer. There are about twenty species.

SCOLOPAX, the *curlew*, in natural history, a genus of birds of the order Grallæ. Generic character: the bill long and incurvated; face covered with feathers; nostrils linear and longitudinal near the base; tongue short and sharp-pointed; toes connected by a membrane to the first point. There are fifty species, of which the following are the chief: S. arquata, or the common curlew, is generally about two feet long, and is to be met with in England throughout the year, either on the coasts or near the mountains. Slugs and worms, which its bill extracts from the ground, in the morning and the evening, constitute its inland subsistence; and when on the shores of the sea it feeds on marine animals. These birds are often observed in large flocks, and are used by many for food. Those killed on the coasts, however, are rank and fishy.

S. rusticola, or the woodcock. These birds are about fourteen inches in length. They are migratory in this country, and supposed to proceed from Sweden. They arrive about the beginning of October, but have never been observed on their first reaching land, and are supposed always to effect this by night or in misty weather. When first seen, they are extremely weak and exhausted, and have sometimes scarcely retained strength enough to fly to a very short distance, having been destroyed in numbers by a stick only. Before the rigours of winter set in, they reside in moory and mountainous districts; but in the extreme cold they change their haunts for such as are lower and warmer, and frequent particularly warm springs in glens and dells, covered with sheltering trees and brushwood. They occasionally breed in this country, some few instances of this having been unquestionably authenticated; but with such very extraordinary exceptions, woodcocks collect together about the middle of March, to return to their native country. They are often, however, like other voyagers, detained by unfavourable winds, and in such circumstances sportsmen find them in considerable numbers, and destroy them with unmerciful eagerness. The woodcock is more remarkable for stupidity than intelligence, and is easily taken in traps and springes, which are placed for it near tepid springs, in passages artificially managed, as this bird never attempts to overcome obstacles in its way, even by leaping only off a small stone. It is, from this indolent tendency, decoyed into the direction, which, however smooth and pleasant at first, terminates in ruin. Its flesh is highly valued, but is considered as affording its full relish only when the bird is dressed entirely undrawn, in which state, with more epicurism than delicacy, it is generally eaten. See Aves, Plate XIII fig. 5.

S. gallinago, or the snipe, weighs about four ounces, is about twelve inches long, and to be found in nearly every country of the world. Its food consists of worms and insects, which it seeks near small streamlets, and in general in wet grounds. It eats also slugs. It is a bird of extreme caution and vigilance, and the sight of the sportsman or the dog impels it to immediate concealment amidst the dry herbage of its haunts, from which the resemblance of colour renders it almost impossible to discriminate it. On the approach of the enemy, it bursts from its shelter with such uncommon variety of direction and velocity of motion, as renders its destruction by the gun one of the greatest achievements of the sportman's art. Snipes are sometimes approached nearly, by the accurate imitation of their sounds, and shot upon the ground, and they are often taken by snares, like the woodcock. The flavour and the preparation of them are also similar. They are in this country migratory, but cases have occurred of their breeding in it.

S. ægocephalus, or the common godwit, is of the weight of twelve ounces, and ranks in the highest order of delicacies. It is found in almost every country, and in the marshy grounds of Lincolnshire and Cambridgeshire is particularly abundant, feeding on insects and small worms, but approaches the sea shore on the advance of the rigours of winter. These birds, in several parts of the country, are

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caught in nets, into which they are deluded by representations of birds of their own species, made of wood, and painted with some correctness of resemblance. After they are taken, they are by some fattened for sale with great facility and success.

S. calidris, or redshank, is not uncommon in this island, and particularly towards the south. It breeds in the marshes, and is remarkable for flying in a direction completely irregular round its nest, by which it is very frequently discovered. Its length is twelve inches. For the redshank, see Aves, Plate XIII. fig. 6.

SCOLOPENDRA, in natural history, *centipede*, a genus of insects of the order Aptera. Antennæ setaceous; two feelers filiform, united between the jaws; lip toothed and cleft; body long, depressed, consisting of numerous transverse segments: legs numerous, as many on each side as there are segments of the body. There are thirteen species, found in almost all parts of the world; they live in decayed wood, or under stones, and some of them in fresh and salt water: they prey on other insects. The larger species are found only in the hotter regions of the globe; they are insects of a terrific appearance, and possess the power of inflicting severe pain and inflammation by their bite.

S. morsitans is a native of Asia, Africa, and South America. It is eight or ten inches long, of a yellowish brown; the head is armed on each side with a very large curved fang, of a strong or horny nature; these fangs are furnished on the inside, near the tip, with an oblong slit, through which, during the act of wounding, an acrimonious or poisonous fluid is discharged; the eyes are numerous on each side the head, and are placed in a small oval group; it has twenty legs on each side of the body.

S. electrica has seventy legs on each side; its body is linear; it inhabits many parts of Europe, in decayed wood, and shines in the dark; the body is very flat and tawny, with a black line down the back The motions of this insect are tortuous and undulatory, seldom continuing long in the same direction. It is possessed of a high degree of phosphoric splendour, which, however, seems to be only exerted when the animal is pressed or suddenly disturbed, when it diffuses a beautiful light, so powerful as not to be obliterated by that of two candles on the same table. It is very tenacious of life, and will endure long in the closest confinement without food.

S. forficata is a very common insect, found frequently under stones and flower-pots; it has a very swift motion, and is furnished with fifteen legs on each side; it is of a chesnut colour, and is about an inch and a half long.

SCOLOPIA, in botany, a genus of the Icosandria Monogynia class and order. Essential character: calyx inferior, three or four-parted; corolla three or four-petalled; berry crowned with the style, one-celled, six-seeded; seeds arilled. There is only one species, *viz.* S. pusilla, a native of Ceylon, where it is called khatu kurundu, or thorny cinnamon.

SCOLOSANTHUS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Luridæ. Rubiaceæ, Jussieu. Essential character: calyx four-cleft; corolla tubular, with a revolute border; drupe one-seeded. There is but one species, *viz.* S. versicolor; this small shrub was discovered in the island of Santa Cruz, by Ryan.

SCOLYMUS, in botany, *golden thistle*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx imbricate, spiny; pappus none; receptacle chaffy. There are three species, natives of the south of Europe.

SCOMBER, the *mackarel*, in natural history, a genus of fishes of the order Thoracici. Generic character: head compressed, smooth; gill membrane with seven rays; body smooth, oblong; lateral line carinate behind; small fins, generally, both above and below, near the tail. There are twenty-one species, of which we shall notice the following:

S. scomber, or the common mackarel. This is one of the most beautiful of fishes, and inhabits both the European and American seas. It is said by many to reside in winter near the North Pole, and, as the spring advances, to move in immense shoals in a southerly direction, traversing a vast space in a short period, and proceeding nearly in a similar line of movement with that attributed to the herring, from the same extremities of the north. Some of the most eminent naturalists, however, have entertained doubts of these extensive voyages in both cases, and it is imagined by such that these fishes take up their residence, during the rigour of winter, in the muddy or gravelly bottoms near the coasts, where they abound so

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numerously in the spring. Shaw relates, that M. Pleville de Peley saw the bottoms near the coasts of Hudson's Bay, for a long space together, bristled with the tails of mackarel, all their other parts being imbedded in the gravel or mud. The mackarel is a fish highly admired, both for its beauty and excellence, and has in every age attracted particular notice and partiality from both these circumstances. The Romans prepared from it a condiment or essence for the table, which was in the highest estimation. The general length of this fish is fifteen inches, but specimens far larger have been occasionally met with.

S. thynnus, or the tunny, is sometimes ten feet long, and on the Scotch coast one was taken which weighed four hundred and sixty pounds. In the Indian ocean it is said to exceed even this enormous size. It is recorded by Pliny, who was sufficiently attached to the marvellous, that the fleet of Alexander met with no slight obstruction from a host of tunnies, which it required considerable manœuvring to break through. These fishes are not particularly admired for food in this country, in which, indeed, they are rarely seen, approaching the British coast only in straggling parties, or rather as solitary individuals. By the ancients, fisheries were established for taking and preserving them on the coasts of the Mediterranean, in which sea they particularly abound, and there are at present on the same coasts very extensive establishments for this purpose. Indeed, by the inhabitants on those shores the movements of tunny are watched and expected with as much eagerness as those of the herring, or mackarel in the north. The small fishes are generally carried fresh to market, and the large ones are cut up into pieces of a particular size, and preserved in salt in barrels. The tunny is a very voracious fish, and a great persecutor of the common mackarel.

SCONCE, in fortification, a small field-fort, built for the defence of some pass.

SCOPARIA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx four-parted; corolla four-parted, wheel-shaped; capsule one-celled, two-valved, many-seeded. There are three species.

SCOPOLIA, in botany, so named in honour of Giovanni Antonio Scopoli, professor of chemistry and botany at Pavia; a genus of the Pentandria Monogynia class and order. Essential character: calyx five-cleft; nectary none; stigma capitate; capsule berried, five-celled; seeds solitary. There are two species, *viz.* S. aculeata and S. inermis.

SCOPUS, the *umbre*, in natural history, a genus of birds of the order Grallæ. Generic character: bill long, thick, compressed, a little hooked; nostrils linear, oblique; feet four-toed, cleft. The only species, the umbretta, or tufted umbre, is about as large as a crow, and twenty inches in length; its bill three inches and a half long; its body of a uniform brown colour, whence it derives its name. It is supposed to be a native of the Cape of Good Hope, but no circumstances of interest have been detailed by travellers of its residence, habits, and manners.

SCORPÆNA, a natural history, a genus of fishes of the order Thoracici. Generic character: the head large, aculeated, cirrhose, obtuse, without scales; somewhat compressed; eyes near each other; teeth in the jaws, palate, and throat; gill membrane seven-rayed; body thick and fleshy; dorsal fin single, long, with the rays of the fore-part spinous. There are nine species enumerated by Gmelin, and fourteen by Shaw. We shall notice only the following:

S. porcus, or the porcine scorpæna, is about fourteen inches long, and an inhabitant of various parts of the Mediterranean, in considerable numbers. It lies near the shores under the stones, apparently in ambush for its prey, which consists particularly of small fishes and sea-insects. It eats also sea-weeds. The rays of its dorsal fin are furnished with strong spines, with which it often inflicts painful, if not dangerous wounds.

S. horrida, is found in the Indian seas, and is about thirteen inches long. The head and body, the pectoral and the dorsal fins, are covered with numerous abrupt cirrhi or beards; all the fins are supplied, on the fore-part, with strong rays, and those of the dorsal extend almost completely along the back. In various other particulars of its form it is singularly uncouth, and altogether presents one of the most repulsive objects which can meet the eye.

SCORPIO, in natural history, a genus of insects of the order Aptera. Generic character: eight legs, besides two claspers, or hands, seated on the fore-part of the head; eight eyes, three placed on each side of the thorax, and two on the back; two feelers projecting cheliform; the lip is bifid, and the tail long, jointed,

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and terminated by a sharp, crooked sting; on the under side, between the breast and abdomen, are two instruments resembling a comb. There are ten species, all of which are armed with a slightly pungent sting; and in hot climates some of them are highly dangerous: they prey upon worms, spiders, flies, &c. and even on one another. S. afer, or great African scorpion, is the largest, and by far the most formidable, of the whole genus: it is held in great dread by the inhabitants: its poison is evacuated through two very small oblong foramina, situated on each side the tip of the sting. Scorpions are viviparous insects, producing a very considerable number of young at once: these are at first entirely white, but acquire their dusky colour in the space of a few days: they are observed to cast their skin from time to time, in the manner of spiders. the larva and pupa are eight-footed, nimble, and resembling the perfect insect.

SCORPION, *scorpio*, in astronomy, the eighth sign of the zodiac, denoted by the character ♏. The stars in the constellation scorpio, in Ptolemy's catalogue, are 20: in Tycho's 10; and in Mr Flamstead's 49.

SCORPION, in the ancient art of war, an engine chiefly used in the defence of the walls of fortified places, by throwing arrows, fire-balls, or great stones.

SCORPIURUS, in botany, *caterpillar*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: legume divided by isthmuses, or transverse partitions, revolute cylindrical. There are four species, all natives of the south of Europe.

SCORSONERA, in botany, *viper's grass*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ Cichoraceæ, Jussieu. Essential character: calyx imbricate with scales, scariose at the edge; pappus feathered, sessile; receptacle naked. There are nineteen species.

SCOT, a customary contribution, laid upon all subjects according to their abilities. Whoever were assessed to any contribution, though not by equal portions, were said to pay scot and lot.

SCOTLAND. By 5 Anne, c. 8, the union of England and Scotland was effected, and the twenty-five articles of union, agreed to by the Parliaments of both nations, were ratified and confirmed as follows: *viz.* the succession to the monarchy of Great Britain shall be the same as was before settled with regard to that of England. The united kingdoms shall be represented by one parliament. There shall be a communication of all rights and privileges between the subjects of both kingdoms, except where it is otherwise agreed. When England raises 2,000,000*l.* by land-tax, Scotland shall raise 48,000*l.* The standards of the coin, of weights, and measures, shall be reduced to those of England throughout the united kingdoms. The laws relating to trade, customs, and the excise, shall be the same in Scotland as in England. But all the other laws of Scotland shall remain in force, though alterable by the Parliament of Great Britain; and particularly, laws relating to public policy are alterable at the discretion of Parliament. Laws relating to private right are not to be altered, but for the evident utility of the people of Scotland. Sixteen peers are to be chosen to represent the peerage of Scotland in Parliament, and forty-five members to sit in the House of Commons. The sixteen peers of Scotland shall have all privileges of Parliament, and all peers of Scotland shall be peers of Great Britain ranking next after those of the same degree at the time of the union, and shall have all privileges of peers, except sitting in the House of Lords, and voting on the trial of a peer.

It was formerly resolved by the House of Lords, that a peer of Scotland, claiming and having a right to sit in the British House of Peers, had no right to vote in the election of the sixteen Scotch peers; and that if any of the sixteen Scotch peers are created peers of Great Britain, they thereby cease to sit as representatives of the Scotch peerage, and new Scotch peers must be elected in their room.

SCOTOGRAPH, an instrument to enable a person to write in the dark, invented by Mr. John Isaac Hawkins, and included in a patent taken out by him in 1803 for several other inventions relating to the graphic art.

Plate Scotograph explains the construction of this instrument. Fig. 1, is a plan of it; fig. 2, 3, and 4, parts; and fig 5, a perspective view of the whole put together. A B D E is a small box, covered with morocco leather, to be carried in the pocket; its lid, F G, is made in two pieces, joined together by hinges in the middle, so as to turn back, as shown in fig. 5. and is kept shut by a small spring catch: *a a* (fig. 1.) is a small brass shell, fixed along one side of the box, at about

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one half of its depth from the bottom; it is also seen in the end section (fig. 4.) *b d e f*, is a small pentagraph made of brass: one end of the rod, *b*, is jointed to a small hinge, *g*, by which its motion allows the whole pentagraph to be lifted up: the other end of the rod, *b*, is jointed to the rod *f*, and the small handle, *h*, or pencil, which the writer holds in his hand when in use, is attached to the other end by an universal joint, which allows it to move in any direction, to imitate as much as possible the motion of a pen: *e* and *d* are the other two bars, completing the pentagraph: *i* is the point which forms the letters; is screwed into the bar *d*: F G is a piece of wood glued to the bottom of the box, with a small piece of ivory fastened upon the top of it, to support the paper while it is written upon: the surface of this ivory is about the same height as the brass shelf, *a a*, as is seen in the section fig 4.: H and I are two small rollers, (one of which is shown separately in fig. 2.) on which the paper is rolled; it is fastened to them at both ends, by a small brass lever, *k*, (fig. 2.) which shuts down in a groove made in the roller: when the paper is put under this lever, and shut down, it is held fast, and by turning the roll is wound upon it: *l m* are two small milled heads, one on each roll, to turn them; at one end of the roll, I, a small ratchet wheel, *t*, of six teeth, is fixed; it is turned round by a click, *k*, (fig. 4.) jointed to a small lever, *l*, which is thrown up by a spring, *m*: *n* (fig. 1.) is a piece of brass plate screwed to the side of the box: it is shown separately in fig. 3. and has two branches, to receive the pivots of the two rollers, H I; these arms are elastic, and press against the ends of the rollers, and cause them to turn rather stiffly, so that they will not be liable to be moved by the elasticity of the paper which is rolled upon them. The pentagraph is of the common kind: the three points, *g i*, and the end of *h*, being all in one line, as explained in the article PENTAGRAPH: the point *i*, which forms the letters, is a short piece of silver wire, screwed into the bar *d*, and pointed at the end to make this mark: the paper is rubbed over with whiting, or chalk; and when at any time the point is worn away, it may be renewed by screwing it through the bar a little further: the point is always made to project so far, that when the blunt point at the end of the pencil, *h*, rests upon the brass shelf, *a a*, the pentagraph will be set a little upon the strain, and by that means press upon the paper with a proper degree of force to write legibly. In using the machine, the lid, F G, is to be half shut, as shown in fig. 5. and thus form a support for the hand while writing; the pencil, *h*, is held in the hand, and pressed down to touch the brass shelf, *a a*, and used in the same manner as a common pen or pencil, taking care always to begin at the end of the shelf; the side of the box, and a small ledge upon the edge of the shelf, limits the height of the letters. When the pencil arrives at the end of the shelf, it is to be brought back again, and the end of it is to be placed upon the end of the lever, *l*, and forced down; the click, *k*, then takes into one of the teeth of the wheel, *t*, and turns it round one tooth; the pressure is then to be removed, and the spring, *m*, lifts up the lever, *l*, just the proper height to catch the next tooth of the wheel, as is shown in fig. 4: this operation moves the paper forward just the proper space to write another line. One of the uses of the pentagraph is to reduce the writing to half the size that it is made on the brass shelf, whereby double the number of lines are contained on a slip of paper that would be if written the full size, and the lines are but half the length, so that room is left at the ends of the rollers for the ratchet wheel and milled nuts. The rollers will hold a slip of thin paper twenty inches long, and contain 100 lines, each of two inches long: this will contain a considerable quantity of information, and when it is all written and rolled upon the roll, I, the lever, *k*, (fig. 2.) of the other roller will be exposed to view; then the pentagraph is to be lifted up upon its hinge, *g*, and the lever raised up by putting the nail under the end of it: this releases one end of the paper; and by pulling it, the other roll will be unwound; and when the small lever of that roller is taken up, the paper will be quite loose: another paper will be fixed with equal ease by first fixing it to the roll H, and rolling it upon it, and then fastening it to the other. If at any time any particular line of the writing is wanted, it will be easily brought into view, by turning the rollers by their nuts, *l*, *m*.

This instrument would be particularly useful to persons who have occasion to make memorandums while on horseback, or travelling in a coach, as any degree of pressure may be given upon the brass shelf while writing, so as to avoid being disturbed by the most violent shocks, which cannot be done upon common pa-

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per for fear of breaking the pencil point, or of piercing the paper by it. Its use to blind people, who have learned to write, is very obvious.

SCRATCH, in the language of the salt-workers of our country, the name of a calcareous, earthy, or stony substance, which separates from sea-water in boiling it for salt. This forms a thick crust, in a few days, on the sides and bottoms of the pans, which they are forced to be at the pains of taking off once in a week, or ten days, otherwise the pans burn away, and are destroyed.

SCREW, one of the five mechanical powers. See MECHANICS.

SCRIBING, in joinery, &c. is a term used when one side of a piece of stuff is to be fitted to another that is irregular. In order to make these join close all the way, they scribe it; that is, they lay the piece to be scribed close to the other they intend to scribe it to, and opening their compasses to the widest distance, these two pieces stand from each other, they bear the point of one of the legs against the side they intend to scribe to, and with the other point draw a line on the stuff to be scribed. Thus they form a line on the irregular piece parallel to the edge of the regular one: and if the stuff be cut exactly to the line, when these pieces are put together they will seem a joint.

SCROPHULARIA, in botany, *figwort*, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character. calyx five-cleft; corolla subglobular, resupine; capsule two celled. There are twenty-two species.

SCROTUM. See ANATOMY.

SCROWLS, or SCROLLS, in architecture, the same with volutes.

SCRUPLE, a weight equal to the third part of a dram, or to twenty grains.—Among goldsmiths it is equal to twenty-four grains.

SCUDDING, in naval affairs, is the movement by which a ship is carried precipitately before a tempest, and is either performed with a sail extended on her foremast, or, if the storm is excessive, without any sail, which is then called scudding under bare poles. In sloops and schooners, and other small vessels, the sail employed for this purpose is called the square-sail. In larger ships it is the fore-sail.

SCULPTURE. It is beyond human research to ascertain when this art was first practised, and by what nation. We may, however, safely conjecture that it was almost one of the original propensities of man, and may be said to have been born with him in every climate. This will still appear in the ardent and irresistible impulse of youth to make representations of objects in wood, and the attempts of savages to embody their conceptions of their idols. If a command from the Author of our being was necessary to prevent the ancient Israelites from making graven images, it may be naturally inferred, that the inhabitants of the rest of the earth possessed similar propensities. The descriptions of the Scriptures demonstrate that the art had been brought to great perfection at the period of which they treat; but they could not be so particular as to enable us to judge whether their excellence approached the remains we possess, derived from other sources.

To proceed methodically on this subject, it becomes necessary to make a distinction between carving and sculpture: the former belonging exclusively to wood, and the latter so stone. It is extremely probable that every essay at imitating animated objects was in each nation made in wood originally, and it is vain to suppose the tools were any other at first than the sharp edges of broken stones or flints; a visit to the Museum will afford the curious spectator a competent idea of the art of carving with instruments of the above description. The least enlightened nations possess individuals of superior observation, who see the defects of their neighbours, and by instruction or ridicule, produce an attempt at reformation: this has evidently been the case amongst the Egyptians and Greeks, who, of all the people of antiquity, made the earliest and greatest progress in the art of sculpture. If the former commenced their imitation of nature in wood, it is probable they soon discovered that it was incapable of a durability commensurate with their wishes; they therefore adopted a close grained and beautiful granite, which not only required tools of iron, but those of the most perfectly tempered steel, to cut it; and with such they have left us at this very distant time vast numbers of excavated figures, as complete and as little injured as if executed within our own memory.

In examining the various sculptures of the Egyptians, we find that a general character prevails throughout their outlines, which demonstrate that the sculptors were natives of Egypt, and that they rigidly copied the expression and charac-

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ter of their countrymen. Had the persons employed in decorating the numerous magnificent works, the ruins of which still surprise the spectator, been invited from other countries, a variation of style in the drawing would have been readily discovered. The circumstance of their figures, both male and female, strongly resembling each other in every instance, proves that this people were not deficient in genius; and their spirited imitations of animals adds to our conviction, that, had nature been more kind to the Egyptians in their forms and features, their sculptors were fully competent to give an accurate representation of personal grace. Their limited and absurd ideas of religion were a decided bar to improvement, and led them to debase rather than improve the human form: hence we sometimes find the heads of animals attached to the bodies of men, and the ridiculous imputed acts of their idols are represented in strange unnatural positions, and those frequently repeated; hence the idea of grouping their figures was decidedly banished, except in a few cases, when the same outline occurs to the depth of four and five persons, each performing the same acts.

The errors of the Egyptians on this head cannot be more forcibly illustrated than by mentioning their manner of expressing a general punishment; a gigantic figure wields a weapon with one hand, and with the other grasps the hair of a group of kneeling figures, placed in a circle, with three ranges of heads appearing above each other, the hands, knees, bodies, and profiles, exactly parallel. A second mistake in their sculpture was the disproportion of their figures to the object decorated with them, as it frequently happens that the same building contains hieroglyphics not three inches in length, which in another part of the structure are extended to several feet. Thus the temple of Apollinopolis Magna, at Etfu, has its side covered with figures half the height of the building, and the front with others not a sixth part of their size.

Their progress in the art of sculpture may be traced by the several gradations in the execution: at first the simple outline, cut very deep, succeeded by rude figures in very flat relief, and ending in bold and perfect forms in alto relievo. Denon has given several valuable specimens of their remains, amongst which are a species of caryatides, or naked figures, standing erect, with their arms crossed on their breasts: these, however, are very little calculated to raise our opinion of the merit of the artists who made them; and, indeed, the only instances we recollect of correctness and propriety are the sphinx, and the enormous clenched hand, now in the British Museum. Of the former, Denon speaks with enthusiasm: "I had only time to view the sphinx, which deserves to be drawn with a more scrupulous attention than has ever yet been bestowed upon it. Though its proportions are colossal, the outline is pure and graceful; the expression of the head is mild, gracious, and tranquil; the character is African; but the mouth, the lips of which are thick, has a softness and delicacy of execution truly admirable; it seems real life and flesh. Art must have been at a high pitch when this monument was executed: for, if the head wants what is called style, that is to say, the straight and bold lines, which give expression to the figures under which the Greeks have designated their deities, yet sufficient justice has been rendered to the fine simplicity and character of nature which is displayed in this figure."

These observations corroborate what we have already advanced of the capability of the Egyptians to execute, had their conceptions been equally correct; but as those were limited, their genius for excellent sculpture can only be collected from detached objects; hence it is that we must look for elegance in their representations of animals, foliage, and flowers, which being admired by all, and not subject to the changes and varieties exhibited in the human frame and countenance, are more readily copied In this part of our pursuit we are again assisted by Denon, who has presented us with many traces of simplicity in the capitals of their pillars, some of which are of about the same degree of excellence with the best specimens of Saxon sculpture, and in some cases strongly remind us of the works of that people; and it may be worthy of observation, that the shape of the Egyptian capital differs very little from the Corinthian of the Greeks: one in particular might be supposed to be the work of the latter, as it is surrounded by a range of beautiful full-grown leaves of the palm, disposed as the acanthus leaf afterwards was; another, formed of a collection of palm-stalks before the branches and leaves are fully developed, shows that a very little taste, added to the disposition, would have raised the reputation of Egyptian sculpture to a level with that of their more polished imitators, as there can be no doubt that they have af-

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forded hints to the Greeks. The frieze of the great temple at Tentyra, also shows, that the ideas of the Egyptians, when confined to objects intended merely for ornament, approached very near perfection; in this instance the sculptures of the wings of birds, variously and tastefully disposed, deserve the approbation of the enlightened observer.

We must now turn our attention to the acknowledged masters of the sublime art of sculpture, the ancient Greeks, to whom every nation of the earth still pays a willing homage, and from whose matchless works each sculptor is happy to concentrate and improve his observations on the human figure, presented by them to his contemplation in its most graceful perfection. Such, indeed, has been the excellence and correctness of their imitations of nature, and the refined elegance of their taste, that many ages have elapsed, not one of which has afforded a single instance of improvement, even in the disposition of their scrolls, or other fanciful ornaments.

As modelling figures in earth has been a practice for ages, previous to their sculpture in stone, it may be supposed that this was the original method of making isolated resemblances of men; indeed, the facility with which alterations and improvements might be accomplished seems to point out the propriety of using that material before the art of cutting stone was invented. Calisthenes, who was an Athenian, made a number of models, with which he adorned his residence; but it is of the sculptor, and not the modeller, that we are to treat at present. Of the latter, we might mention a very considerable number, whose names have reached us with their works, were they necessary, and yet, compared with the statues distributed in every part of Europe, they are a very inconsiderable portion of the eminent men, who have flourished in the different states of Greece. When we contemplate the beautiful specimens of their consummate art, we are at a loss which most to admire, the softness and delicacy given to the marble, or the exquisite skill demonstrated in every feature and muscle, which could only have been acquired by the most attentive observation of living subjects, placed in each natural and easy attitude. Had not the people generally admired and respected the arts, so great a degree of perfection would never have been attained; for the operation of producing a fine figure requires a mind at ease, and the means of subsistence beyond the mere wants of the day; it is therefore extremely probable, that those who employed statuaries to perpetuate the memory of great men, and to honour their gods with their representations as votives to the numerous temples, made liberal remuneration, and it is to be hoped equal to the merit of the work.

The Romans were fully sensible of the superior excellence of the Greeks in sculpture, and although we cannot approve of their motives in plundering them of their best works, yet we involuntarily feel satisfied, that it is through their rapacity that we now possess those fascinating models for imitation, which has formed the taste of the Italian sculptors, and excited that emulation, which enabled artists to rouse the public mind to a state of enthusiasm sufficiently powerful to crowd churches and palaces with mementoes of the great and good Besides this superior branch of the art, we are not less indebted to the ancient Grecians for the invention and distribution of the most refined taste in the inferior parts of sculpture: under this head we need only remind the reader of the grand conceptions distributed from the base to the summit of Grecian buildings, in reliefs of various rich ornaments.

It appears almost superfluous to mention the Laocoon, the Venus de Medicis, the Apollo Belvidere, the Meleager, the Antinous, the Niobe, &c. &c. of the Grecian school, as efforts never to be exceeded, or perhaps equalled. How does this fact exalt the character of the people thus favoured, and how does it humble the pride of the moderns! And yet the knowledge of infinite superiority attached to them should not depress the efforts of the student, but rather rouse him to increased exertion; at all events recollecting, that Phidias, Praxiteles, Agesander, Polydore, and Athenodorus, studied models far beyond the reach of perfect imitation, even the animated human form.

Our limits will not permit us to enlarge, or enter into an inquiry as to the comparative merits of the different modern schools of Europe, of which Italy bears away the unrivalled palm, through several concurrent circumstances, and of those it is immediately obvious, that piety and superstition are the principal; the legends of their saints produce an incredible variety, for illustrating the violent emotions of the soul in ardent devotion and the pangs of martyrdom, and it can-

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not to be disputed, that they have in many instances very nearly approached the expression and excellence of their masters: of those, Michael Angelo Buonaroti has been honoured by his countrymen with the title of divine, nor was Benini much less deserving of this honour.

The French, although favoured with a climate little inferior to that of Italy, and situated upon its borders, have less distinguished themselves in sculpture than might have been expected; but the national character is too volatile for the productions of tedious and incessant exertion, absolutely necessary in the sculptor; hence it is, that very few French names are celebrated as statuaries. It would, however, be unjust, not to mention Roubiliac, who honoured England with his works, which deserve every praise for just conception, and perhaps there is no modern instance of more beautiful contrast than in his monument to the memory of Lady Nightingale, in Westminster Abbey, on which the lifeless figure of the dying lady, and the eager and terrified husband, have, and ever will be greatly admired. The skeleton, wrapped in sepulchral drapery, aiming a dart at the breast of the female, needs no other encomium than that of the celebrated anatomist, John Hunter, who pronounced it a most perfect representation. Francois Girardon should also be mentioned as doing honour to the French nation, by his numerous works, and by none more than his tomb of Cardinal Richlieu, originally placed in the college of the Sorbonne, at Paris.

The Germans and Dutch have distinguished themselves greatly in painting, but taking the subject in an enlarged point of view, they have done next to nothing in sculpture; neither has the Spanish nation any very strong claim to distinction on this head. The sculpture of Great Britain is almost entirely confined to the interiors and exteriors of churches, and the statues which adorn them are all, without exception, ancient: when the religion of our ancestors was the same as that of the greatest part of the continent of Europe, they gave large sums for the production of shrines and saints without number; but they seem to have had no idea of encouraging the noblest part of the art, by selecting men of superior genius, and employing them on groups or single figures in white marble, the only substance calculated to give due effect to the skill of the statuary; this parsimonious conduct, and probably very indifferent rewards, was the cause that all our old statues are made of coarse and perishable stone, and that they are, in truth, little better than copies of each other, which circumstance may be partly accounted for; besides, by the situations they occupied on the walls of sacred edifices, and their being invariably placed in niches, and those in the pointed style of architecture, whence it became a matter of necessity to introduce but one figure, and that in an upright position; yet, under all these disadvantages, a competent judge may discover in the majority of the works of our ancient sculptors a freedom and correctness that would, with due encouragement, have produced works little, if at all, inferior to those of the Italian school. If we examine the turns or lines of the faces of the kings and saints, scattered over the surfaces of our cathedrals and some parish churches, it will be found that the artists who made them were capable of expressing dignity and piety, and their drapery is generally correspondent to the position of the limbs, and in large graceful folds. The admirer of this art cannot fail of being highly gratified, by tracing the progress of English sculpture in that vast field for observation, Westminster Abbey; where, in the cloisters, they will find the rude figures of abbots coeval with the time of William of Normandy, from which period down to the present moment, there is almost an annual succession of figures, ornamental and monumental.

The Abbey having been partly rebuilt by Henry III. the structure was continued as the abbots could obtain the means; consequently there is an actual gradation in the excellence of the sculpture, down to the reign of Henry VII. The latter monarch determined to excel all his predecessors, and his chapel, or burial-place, is one blaze of rich decoration, in every possible direction. Having thus directed the attention of the reader to the place where a perfect knowledge of this subject may be obtained, we shall proceed to notice another branch of the art, which has been continued in Great Britain from the time of the reformation, at which period sculpture received its fiat, as far as relates to the use of it for pious purposes. We know but little of the statutes which were placed about the altars and shrines of old times in this country, as they were destroyed without mercy, but vast numbers of tombs remain uninjured in every county: in speaking of those, we must premise, that very little opportunity was given the artist to expand and improve his ideas, as a slavish custom prevailed of

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placing all the statues on them in a posture, of all others, the most ridged and ungraceful, which was on their backs, and with the hands joined in prayer: under this obvious disadvantage our ancient sculptors contrived to make many excellent and interesting figures in beautiful transparent alabaster although almost all the males are represented in armour. As the effigies of persons were frequently accompanied by that of their consorts, more scope for genius and variety prevailed in the latter, and consequently we find females in the habits of their times, and represented in the rich ornaments of the sex, and making due allowance for the stiffness of their cumbent position, the drapery is frequently placed in true and well conceived folds: as to expression in the features beyond a mere state of quiet, as it would not have been proper, it is not to be discovered in any instance. Some of the tombs under consideration are divided into compartments, in each of which small bas reliefs are introduced of the children of the deceased, or monks or nuns telling their beads; these are frequently well executed, and so far so, as to make us wish the artist had been indulged to the full extent of his abilities.

It appears, upon an attentive comparison, that the figures, executed between the reigns of Henry III and Henry VII. are infinitely superior to those placed on tombs during and after the time of Henry VIII. as in his and the two preceding reigns, the effigies were generally exhibited either kneeling at prayer, or cumbent, in a most miserable taste indeed, which was made still more disgusting by the custom of painting and gilding the drapery. In the period of the interregnum, nothing was done in the art of sculpture, as, unfortunately, the era alluded to completed the destruction begun at the reformation, by the application of a blind principle of dislike, which prevented the preservation of the statues of saints, not as objects to excite devotion, but as the only mementos that existed that the art had ever been encouraged in England

As might have been anticipated, sculpture sunk into a state of total neglect, if not of contempt; but after the restoration, the ancient habits of the people recurring, statues of the dethroned king, and of his son and successor, were erected in every direction, and in some instances they are tolerable figures; but the monumental of the same date are wretched indeed, as they are clad in Roman armour, and their heads and shoulders sustain enormous wigs. Encouragement increasing, the art began to rouse from its torpid state, and at length Cibber flourished, to whom we are indebted for many very excellent statues, and some rich embellishments at St. Paul's cathedral. Without invidiously mentioning names and making comparisons, it would be impossible to enter more fully into the progress of sculpture since the date just mentioned; we shall therefore merely say that numerous proofs exist, that the modern English possess a genius for sculpture equal to the inhabitants of any nation, but unfortunately it seems to be nearly confined to the execution of monuments, on which a routine of genii, ancient gods and goddesses, and virtues, are constantly introduced, to the total extinction of taste, as they must each possess their attributes, to point out their names.

Little need be said of the mechanical part of this art, as various chissels, a mallet, compasses, and materials for polishing marble, are all that is required; the essential is seated in the mind, and as Roubiliac used to say, "the figure is in the substance of the marble, I only extricate it from the enclosure, or pick it out."

SCUTAGE, was anciently a tax imposed on such as held lands, &c. by knight's service, towards furnishing the King's army: hence scutagio habendo was a writ that lay for the king, or other lord, against tenants holding by knight's service, to serve in person, or send a sufficient man in their room, or pay a certain sum, &c.

SCUTELLARIA, in botany, *skull-cap*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx with an entire mouth, after flowering closed by a lid. There are sixteen species: these are all perennial plants, chiefly herbaceous, with square stalks, and opposite leaves; the flowers are either solitary, axillary, and naked, or else in terminating bracted spikes, with one bracte, or floral leaf, to each flower; they are chiefly natives of the south of Europe.

SCUTTLES, in a ship, square holes cut in the deck, big enough to let in the body of a man, serving to let people down into any room below upon occasion, or from one deck to another. They are generally before the main-mast, before the knight in the forecastle; in the gun-room, to go down to the stern-sheets; in the round-house, to go down into the captain's cabin. when forced by the enemy in a fight aloft. There are also some smaller scuttles, which have gratings over them: and all

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of them have covers, that people may not fall down through them in the night. Scuttle is also a name given to those little windows and holes which are cut out in cabins, to let in light.

SCYLLÆA, in natural history, a genus of the Vermes Mollusca class and order. Body compressed, and grooved along the back; mouth consists of a terminal toothless aperture; tentacula, or arms, three on each side, and placed beneath. Two species are noticed, *viz.* the Pelagica and Gomphodensis.

SCYTHROPS, the *channel-bill*, in natural history, a genus of birds of the order Picæ. Generic character: the bill large, convex, cultrated, furrowed at the sides, hooked at the tip; nostrils round, naked at the base of the bill; tongue cartilaginous, split at the point; toes two before, and two behind; tail of ten feathers. Of this genus only one species is known. This is an inhabitant of New South Wales, and is generally designated as the New South Wales channel-bird. Its size is that of a crow; but its length is considerably greater, measuring two feet seven inches. It is seldom seen, excepting in the morning and evening, generally in pairs, sometimes in very small flocks; its noise resembles the screaming sound of alarm uttered by poultry in danger. It is migratory, and supposed to feed on the seeds of trees, on fruits, and the exuviæ of beetles. The tail is sometimes unfolded like a fan, both during the flight and sitting of the bird, and gives it an interesting and dignified appearance. It appears not to be easily tameable; but of the nature, manners and habits of this bird, little is at present ascertained.

SEA, is frequently used for that vast tract of water encompassing the whole earth; but is more properly a part or division of these waters, and is better defined, a lesser assemblage of water, which lies before, and washeth the coasts of some particular countries, from whence it is generally denominated, as the Irish Sea, the Mediterranean Sea, the Arabian Sea, &c.

What proportion the superficies of the sea bears to that of the land is not precisely known, though it is said to be somewhat more than two-thirds As the waters of the earth must necessarily rise to the surface thereof, as being specifically lighter than the earth, it was necessary there should be large cavities therein, for receptacles to contain them, otherwise they would have overspread all the superficies of the earth, and so have rendered it utterly uninhabitable for terrestrial animals; for the centre of the earth being the common centre of gravity; and the nature of fluids being such, that they equally yield to equal powers; and the power of attraction being every where equal at equal distances from the centre; it follows, that the superficial parts of the water will every where conform themselves to an equidistant situation from the centre, and, consequently, will form the surface of a sphere, so far as they extend. Hence, that the sea seems higher than the earth or land, results from the fallacy of vision, whereby all objects and the parts of land as well as sea, the further they are off from us, the higher they appear; the reason of all which is plain from optics: for it is well known, that the denser any medium is, through which we behold objects, the greater is the refraction; or the more their images appear above the horizontal level; also the greater quantity of the medium the rays pass through, the more will they be bent from their first direction; on both these accounts, the appearances of things remote, and on the sea, will be somewhat above the horizon, and the more so as they are the more remote.

With regard to the depth or profundity of the sea, Varenius affirms that it is in some places unfathomable, and in other places very various, being in certan places $\frac{1}{20}$, $\frac{1}{8}$, $\frac{45}{100}$, $1\frac{1}{10}$, $2\frac{2}{10}$, $4\frac{1}{2}$ English miles, in other places deeper, and much less in bays than in oceans In general the depths of the sea bear a great analogy to the height of mountains on the land, so far as is hitherto discovered: and it is a general rule among sailors, and is found to hold true in many instances, that the more the shores of any place are steep and high, forming perpendicular cliffs, the deeper the sea is below; and that, on the contrary, level shores denote shallow seas. Thus the deepest part of the Mediterranean is generally allowed to be under the height of Malta. And the observation of the strata of earth and other fossils, on and near the shores, may serve to form a good judgment as to the materials to be found in its bottom. For the veins of salt and of bitumen doubtless run on the same, and in the same order, as we see them at land: and the strata of rocks that serve to support the earth of hills and elevated places on shore, serve also, in the same continued chain to support the immense quantity of water in the basin of the sea.

The coral fisheries have given occasion

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to observe that there are many, and those very large, caverns or hollows in the bottom of the sea, especially where it is rocky; and that the like caverns are sometimes found in the perpendicular rocks which form the steep sides of those fisheries. These caverns are often of great depth, as well as extent, and have sometime wide mouths, and sometimes only narrow entrances into large and spacious hollows.

The bottom of the sea is covered with a variety of matters, such as could not be imagined by any but those who have examined into it, especially in deep water, where the surface only is disturbed by tides and storms, the lower part, and consequently its bed at the bottom, remaining for ages, perhaps, undisturbed. The soundings, when the plummit first touches the ground, on approaching the shores, give some idea of this. The bottom of the plummit is hollowed, and in that hollow there is placed a lump of tallow; which being the part that first touches the ground, the soft nature of the fat receives into it some parts of those substances which it meets with at the bottom: this matter, thus brought up, is sometimes pure sand; sometimes a kind of sand made of the fragment of shells, beaten to a sort of powder; sometimes it is made of a like powder of several sorts of corals; and sometimes it is composed of fragments of rocks; but beside these appearances, which are natural enough, and are what might well be expected, it brings up substances which are of the most beautiful colours.

Dr. Donati, in an Italian work, containing an essay towards a natural history of the Adriatic Sea, has related many curious observations on this subject; having carefully examined the soil and productions of the various countries that surround the Adriatic Sea, and compared them with those which he took up from the bottom of the sea, he found that there is very little difference between the former and the latter. At the bottom of the water there are mountains, plains, vallies and caverns, similar to those upon land. The soil consists of different strata, placed one upon another, and mostly parallel and correspondent to those of the rocks, islands, and neighbouring continents. They contain stones of different sorts, minerals, metals, various petrified bodies, pumice stones, and lavas formed by volcanoes.

One of the objects which most excited his attention was a crust, which he discovered under the water, composed of crustaceous and testaceous bodies, and beds of polypes of different kinds, confusedly blended with earth, sand, and gravel; the different marine bodies which form this crust are found at the depth of a foot or more, entirely petrified, and reduced into marble; these, he supposes, are naturally placed under the sea when it covers them, and not by means of volcanoes and earthquakes, as some have conjectured. On this account he imagines, that the bottom of the sea is constantly rising higher and higher, with which other obvious causes of increase concur; and from this rising of the bottom of the sea, that of its level or surface naturally results; in proof of which, this writer recites a great number of facts.

M. Dassie has been at great pains to prove, that the sea has a general motion, independently of winds and tides, and of more consequence in navigation than is generally supposed. He affirms, that this motion is from east to west, inclining towards the north, when the sun has passed the equinoctial northward, and that during the time the sun is in the northern signs: but the contrary way, after the sun has passed the said equinoctial southward: adding, that when this general motion is changed, the diurnal flux is changed also; whence it happens, that in several places the tides come in during one part of the year, and go out during the other, as on the coasts of Norway, in the Indies at Goa, Cochin China, &c. where, while the sun is in the summer signs, the sea runs to the shore: and when in the winter signs, runs from it. On the most southern coasts of Tonquin and China, for the six summer months, the diurnal course runs from the north with the ocean; but the sun having re-passed the line toward the south, the course declines also southward.

There are two principal reasons why the sea does not increase by means of rivers, &c. falling every where into it. The first is, because waters return from the sea by subterranean cavities and aqueducts, through various parts of the earth. Secondly, because the quantity of vapours raised from the sea, and falling on the land, only cause a circulation, but no increase of water. It has been found, by calculation, that in a summer's day there may be raised in vapours, from the Mediterranean Sea, 5,280,000,000 tons of water; and yet this sea receiveth not, from all its nine great rivers, above 1,827,000,000 tons per day, which is but

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a third part of what is exhausted in vapours.

The ascent of the sea-water, for the formation of springs, by a subterranean circulation of its water to their sources, has been a great objection, with many, against the system of their being formed of the sea; but Dr Plot has observed, that there are many ways by which the water may ascend above its own level: 1. By the means of subterranean heats. 2. By filtration. 3. By the unequal height of several seas. 4. By the distance of the centre of magnitude from the centre of gravity, in the terraqueous globe: the superficies of the Pacific Sea is said to be further from the centre of gravity, than the top of the highest hill on the adverse part of the globe. And, 5. By the help of storms. The sea-water actually ascends above its own level, coming into wells whose bottoms lie higher than the surface of the sea at high-water mark.

With regard to the saltness of the sea-water, it is very rationally judged to arise from great multitudes both of mines and mountains of salt, dispersed here and there in the depths of the sea. The salt being continually diluted and dissolved by the water, the sea becomes impregnated with its particles throughout; and for this reason the saltness of the sea can never be diminished Dr. Halley supposes, that it is probable the greatest part of the sea-salt, and of all salt lakes, as the Caspian Sea, the Dead Sea, the Lake of Mexico, and the Titicaca, in Peru, is derived from the water of the rivers which they receive; and since this sort of lakes has no exit or discharge but by the exhalation of vapours; and also since these vapours are entirely fresh, or devoid of such particles; it is certain, that the saltness of the sea and such lakes must, from time to time, increase, and therefore, the saltness at this time is greater than at any time heretofore He further adds, that if, by experiments made in different ages, we could find the different quantity of salt which the same quantity of water (taken up in the same place, and in all other the same circumstances) would afford, it would be easy from thence, by rules of proportion, to find the age of the world very nearly, or the time wherein it has been acquiring its present saltness.

The Bishop of Landaff has recommended a most simple and easy mode of ascertaining the saltness of the sea in any latitude: we insert it in his own words.

"As it is not every person who can make himself expert in the use of the common means of estimating the quantity of salt contained in sea-water, I will mention a method of doing it, which is so easy and simple that every common sailor may understand and practise it, and which, from the trials I have made of it, seems to be as exact a method as any that has yet been thought of. Take a clean towel, or any other piece of cloth, dry it well in the sun, or before the fire, then weigh it accurately, and note down its weight; dip it in the sea-water, and when taken out, wring it a little, till it will not drip when hung up to dry; weigh it in this wet state, then dry it either in the sun, or at the fire, and, when it is perfectly dry, weigh it again. The excess of the weight of the wet cloth above its original weight, is the weight of the sea-water imbibed by the cloth; and the excess of the weight of the cloth after being dried, above its original weight, is the weight of the salt retained by the cloth; and by comparing this weight with the weight of the sea-water imbibed by the cloth, we obtain the proportion of salt contained in that species of sea-water.

"Whoever undertakes to ascertain the quantity of salt contained in sea-water, either by this or any other method, would do well to observe the state of the weather preceding the time when the sea-water is taken out of the sea, for the quantity of salt contained in the water near the surface may be influenced both by the antecedent moisture and the antecedent heat of the atmosphere."

Whether the sea is salter or not at different depths, has not yet been properly ascertained; but that its temperature varies considerably in proportion to the depth, we have decisive proof.

"With respect to the temperature," says Bishop Watson, "of the sea at different depths, it seems reasonable enough to suppose, that in summer time it will be hotter at the surface than at any considerable depth below it, and that in winter it will be colder.

"Mr. Wales describes the instrument he made use of for trying the temperature of the sea at differeat depths in the following terms: 'The apparatus for trying the sea-water at different depths consisted of a square wooden tube, of about eighteen inches long, and three inches square externally. It was fitted with a valve at the bottom, and another at the top, and had a contrivauce for suspend-

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ing the thermometer exactly in the middle of it. When it was used, it was fastened to the deep sea-line, just above the lead, so as all the way as it descended, the water had a free passage through it, by means of the valves which were then both open; but the instant it began to be drawn up, both the valves closed by the pressure of the water, and of course the thermometer was brought up in a body of water of the same temperature with that it was let down to.' With this instrument, which is much the same with one formerly described by Mr. Boyle, in his observations about the saltness of the sea, water was fetched up from different depths, and its temperature accurately noticed, in different seasons and latitudes.

"August 27, 1772, south latitude 24° 40′. The heat of the air was 72½, of the water at the surface 70, of water from the depth of 80 fathoms 68.

"December 27, 1772, south latitude 58° 21′. The heat of the air was 31, of the water at the surface 32, of water from the depth of 160 fathoms 33½.

"In the voyage to the high northern latitudes before mentioned, they made use of a bottle to bring up water from the bottom, which is thus described; 'The bottle had a coating of wool, three inches thick, which was wrapped up in an oiled skin, and let into a leather purse, and the whole inclosed in a well pitched canvass bag, firmly tied to the mouth of the bottle, so that not a drop of water could penetrate to its surface. A bit of lead, shaped like a cone, with its base downwards, and a cord fixed to its small end, was put into the bottle; and a piece of valve leather, with half a dozen slips of thin bladder, were strung on the cord, which, when pulled, effectually corked the bottle on the inside' We have here put down two of the experiments which were made during that voyage.

"August 4, 1773, north latitude 80° 30′. The heat of the air was 32, of the water at the surface 36, of water fetched up from the depth of 60 fathoms under the ice, 39.

"September 4, 1773, north latitude 65°. The heat of the air was 66½, of the water at the surface 55, of water from the depth of 683 fathoms, 40.

"It appears from all these experiments, that, when the atmosphere was hotter than the surface of the sea, the superficial water was hotter than that at a great depth; and when the atmosphere was colder than the surface of the sea, it is evident that the superficial water was somewhat colder than at a considerable distance below it"

Sea-water may be rendered fresh by freezing, which excludes or precipitates the saline particles; or by distillation, which leaves the salt in a mass at the bottom of the vessel. Upon these principles, a mode of obtaining a supply of fresh water at sea was recommended some years ago to the Admiralty, by Dr. Irving. It consisted in only adapting a tin tube of suitable dimensions to the lid of the common ship's kettle, and condensing the steam in a hogshead which served as a receiver. By this mode a supply of twenty-five gallons of fresh water per hour might be obtained from the kettle of one of our ships of war.

The saline taste of sea-water, is chiefly derived from common salt which it holds in solution. Sea-water is also distinguished by a nauseous bitter taste, which is ascribed to the animal and vegetable matters which are floating in it. This taste has been considered as in some measure foreign to it, for it is only found in the water on the surface of the ocean, or near the shores. Sea-water, taken up at considerable depths, contains only saline matters. The specific gravity of sea-water varies from 1.027 to 1.028. Its greater density is owing to the salts which are dissolved in it; and to this impregnation also it is owing, that it is not frozen till the temperature is reduced nearly to 28°. The salts which are chiefly found in sea-water are, muriate of soda, or common salt, muriate of magnesia, sulphate of magnesia, sulphate of lime and soda. The quantity of saline ingredients in the waters of the ocean varies from $\frac{1}{24}$ to $\frac{1}{34}$ part. Mr. Kirwan makes the average quantity about $\frac{1}{28}$ of its whole weight. The quantity of saline contents of water, taken up by Lord Mulgrave at the back of Yarmouth Sands, in latitude 53°, amounted nearly to $\frac{1}{32}$; while Bergman found the water taken up in the latitude of the Canaries, to contain about $\frac{1}{24}$ of its weight of saline matter. These quantities, however, vary, even in the same latitude, during rain and dry seasons, near the land, or the mouths of great rivers. The difference of latitude does not seem to make any considerable difference in the proportion of saline matter. In latitude 80° north, sixty fathoms under ice, sea-water, taken up by Lord Mulgrave, yielded about $\frac{1}{28}$; in latitude 74°,

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nearly the same; and in latitude 60°, $\frac{1}{29}$. Pages obtained four per cent. from water taken up in latitude 81°, and the same quantity of saline matter from water taken up in latitudes 45° and 39° north. In southern latitudes the proportion was still greater; he found it to contain the following proportions: In the Mediterranean, the proportion is said to be still greater; but the Euxine and Caspian seas are found to be less salt than the ocean. This is also the case with the Baltic. If the saline matters of the waters of the ocean did not consist of different kinds, the proportion of salts which it contains might be ascertained by the specific gravity. The experiments of Mr. Wilcke show that the proportion of saline matter in the Baltic is less than that of the ocean: and that it is salter during the prevalence of a westerly wind, by which the water is driven from the ocean, than during any easterly wind. The proportions of the different salts in an analysis, by Bergman, are the following:

Muriate of soda .	30 911
Muriate of magnesia	6.222
Sulphate of lime .	1.000
	38.133

In 1,000 parts of water taken up near Dieppe, Lavoisier found the following salts:

Muriate of soda	1375
Muriate of lime and magnesia	256
Muriate of magnesia . . .	156
Lime	87
Sulphate of soda and magnesia	84
	1958

The luminousness of the sea is a phenomenon that has been noticed by many nautical and philosophical writers. Mr. Boyle ascribes it to some cosmical law or custom of the terrestrial globe, or at least of the planetary vortex.

The Abbé Nollet was long of opinion, that the light of the sea proceeded from electricity; and others have had recourse to the same principle, and shown that the luminous points in the surface of the sea are produced merely by friction.

There are, however, two other hypotheses, which have more generally divided between them the solution of this phenomenon; the one of these ascribes it to the shining of luminous insects or animalcules, and the other to the light proceeding from the putrefaction of animal substances. The Abbé Nollet, who at first considered this luminousness as an electrical phenomenon, having had an opportunity of observing the circumstances of it when he was at Venice in 1749, relinquished his former opinion, and concluded that it was occasioned either by the luminous aspect, or by some liquor or effluvia of an insect, which he particularly describes, though he does not altogether exclude other causes, and especially the spawn or fry of fish. A similar conjecture is proposed by a correspondent of Dr. Franklin, in a letter read at the Royal Society in 1.56; the writer of which apprehends, that this appearance may be caused by a great number of little animals, floating on the surface of the sea. And Mr. Forster, in his account of a voyage round the world with Captain Cook, describes this phenomenon as a kind of blaze of the sea; and having attentively examined some of the shining water, expresses his conviction that the appearance was occasioned by innumerable minute animals of a round shape, moving through the water in all directions, which show separately as so many luminous sparks when taken up on the hand: he imagines that these small gelatinous luminous specks may be the young fry of certain species of some medusæ or blubber. And M. Dagelat and M. Rigaud observed several times, and in different parts of the ocean, such luminous appearances by vast masses of different animalcules; and a few days after the sea was covered, near the coasts, with whole banks of small fish in innumerable multitudes, which they supposed had proceeded from the shining animalcules.

But M. le Roi, after giving much attention to this phenomenon, concludes, that it is not occasioned by any shining insects, especially as, after carefully examining with a microscope, some of the luminous points, he found them to have no appearance of an animal; and he also found, that the mixture of a little spirits of wine with water just drawn from the sea would give the appearance of a great number of little sparks, which would continue visible longer than those in the ocean: the same effect was produced by all the acids, and various other liquors. M. le Roi is far from asserting that there are no luminous insects in the sea; for he allows that several gentlemen have found them; but he is satisfied that the sea is luminous chiefly

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on some other account, though he does not so much as offer a conjecture with respect to the true cause.

Other authors, equally dissatisfied with the hypothesis of luminous insects for explaining the phenomenon which is the subject of this article, have ascribed it to some substance of the phosphoric kind, arising from putrefaction.

SEA, in law: The sea shall be open to all merchants. The main sea beneath the low water mark, and round England, is part of England; and the admiralty has jurisdiction there.

SEAMEN, such as are reserved to serve the king, or other persons at sea, who may not depart without license, &c. Seamen fighting, quarrelling, or making any disturbance, may be punished, by the commissioners of the navy, with fine and imprisonment. Registered seamen are exempted from serving in any parish office, &c. and are allowed bounty money besides their pay. By the law of merchants, the seamen of a vessel are accountable to the master or commander, and the master to the owners, and the owners to the merchants, for damages sustained, either by negligence or otherwise. Where a seaman is hired for a voyage, and he deserts it before it is ended, he shall lose his wages; and in case a ship be lost by a tempest, or in a storm, the seamen lose their wages, as well as the owners their freight.

SEAMEN, in law: by various statutes, sailors, having served the king for a limited time, are free to use any trade, or profession, in any town of the kingdom. By 2 George II. c. 36. made perpetual by 2 George III. c. 31. no master of any vessel shall carry to sea any seaman, his own apprentice excepted, without first entering into an agreement with such seaman for his wages; such agreement to be made in writing, and to declare what wages such seamen is to receive during the whole of the voyage, or for such time as shall be therein agreed upon; and such agreement shall also express the voyage for which such seaman was shipped to perform the same, under a penalty of 10*l.* for each mariner carried to sea without such agreement, to be forfeited by the master to the use of Greenwich Hospital. This agreement is to be signed by each mariner within three days after entering on board such ship, and is, when executed, binding on all parties.

SEAL, a puncheon, or piece of metal, or other matter, usually either round or oval, whereon are engraven the arms, device, &c. of some prince, state, community, magistrate, or private person, often with a legend or subscription, the impression whereof in wax, serves to make acts, instruments, &c. authentic.

Before the time of William the Conqueror, the makers of all deeds only subscribed their names, adding the sign of the cross, and a great number of witnesses; but that monarch and the nobility used seals with their arms on them, which example was afterwards followed by others. The colour of the wax wherewith this King's grants were sealed was usually green, to signify that the act continued fresh for ever, and of force. A seal is absolutely necessary in respect of deeds, because the sealing of them makes persons parties thereto, and without being sealed, they are void in law.

SEALER, an officer in chancery, appointed by the Lord Chancellor, or Keeper of the great seal, to seal the writs and instruments there made in his presence.

SEAMS *of a ship*, are places where her planks meet and join together. There is also a kind of peculiar seam in the sewing of sails, which they call monk-seam; the other seam of a sail is the round-seam, so called from its being round like the common seams.

SEARCHER. See ALNAGER. Searcher is also an officer of the customs, whose business is to search and examine all ships outward bound, to see whether they have any prohibited or unaccustomed goods on board.

SEAR *cloth*, or CERE *cloth*, in surgery, a form of external remedy somewhat harder than an unguent, yet softer than an emplaster, though it is frequently used both for the one and the other. The sear-cloth is always supposed to have wax in its composition, which distinguishes, and even denominates it. In effect, when a liniment or unguent has wax enough in it, it does not differ from a sear-cloth.

SEBACIC *acid*, the acid of fat. The penetrating fumes which are exhaled from melted tallow, and which affect the eyes, the nostrils, and even the lungs, had been long ago observed. Little attention, however, was paid to their nature and properties. In 1754, appeared a dissertation by M. Seguer, on the acid of animal fat, which contained a number of well conducted experiments. Crell endeavoured to improve the process for the separation and purification of this acid, and to ascertain the properties of its combinations. These were published in the

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Philosophical Transactions for the years 1780 and 1782 But it appears, that the acid obtained by those who first treated of the subject was either the acetic acid, or some acid different from the sebacic, the properties of which are quite distinct from those which had been formerly described. The process by which Thenard obtained the sebacic acid is the following. He distilled a quantity of hog's lard, and washed the product several times with hot water. He then dropped into it acetate of lead; there was formed a flaky precipitate, which was collected and dried put into a retort with sulphuric acid and heated. The liquor in the receiver had no acid character; but there appeared in the retort a melted matter analogous to fat This is carefully separated, and after being washed, is boiled with water. By the action of heat the whole is dissolved by the water, and when it cools, crystals in the shape of needles are deposited. These are the sebacic acid, which has the following properties. It has no smell, a slight acid taste, and reddens strongly the tincture of turnsole. When heated it melts like tallow. It is much more soluble in warm than in cold water. Alcohol dissolves it in large quantities. Boiling water saturated with this acid forms a solid mass on cooling. It crystallizes in small needles, but with certain precautions may be obtained in the form of long, large, and very brilliant plates. It precipitates the acetate and nitrate of mercury and lead, and nitrate of silver; it neutralizes the alkalies, and forms with them soluble salts.

SEBATES, in chemistry, salts formed of the sebacic acids, and alkalies, earths, &c.; they are soluble in water.

SECALE, in botany, *rye*, a genus of the Triandria Digynia class and order. Natural order of Gramina or Grasses Essential character: calyx opposite, two-valved, two-flowered, solitary. There are four species, *viz.* the villosum, orientale, creticum, and cereale. S villosum, or wood-rye-grass, is distinguished by a calyx with wedge-shaped scales, and by the fringe of the glume being woolly. The glumes of the S. orientale are shaggy, and the scales of the calyx are shaped like an awl. The glumes of the S creticum are fringed on the outside. The S. cereale, or common rye, has glumes with rough fringes. It is a native of the island of Candia, was introduced into England many ages ago, and is the only species of rye cultivated in this kingdom. There are, however, two varieties, the winter and spring rye, The winter rye, which is larger in the grain than the spring rye, is sown in autumn, at the same time with wheat, and sometimes mixed with it; but as the rye ripens sooner than the wheat, this method must be very exceptionable. The spring rye is sown along with oats, and usually ripens as soon as the winter rye; but the grain produced is lighter, and it is therefore seldom sown except where the autumnal crop has failed. Rye is commonly sown on poor, dry, limestone, or sandy soils, where wheat will not thrive. By continuing to sow it on such a soil for two or three years, it will at length ripen a month earlier than that which has been raised for years on strong cold ground.

SECANT, in geometry, is a line that cuts another, or divides it into two parts.

In trigonometry, the secant denotes a right line drawn from the centre of a circle, which, cutting the circumference, proceeds till it meets with a tangent to the same circle.

SECHIUM, in botany, a genus of the Monoecia Syngenesia class and order. Natural order of Euphorbiæ, Jussieu. Essential character: calyx half five-cleft; corolla five-cleft, with ten hollows in the upper part of the tube; nectary; male, filaments five, connected; female, stigma very large, peltate reflexed, five-cleft; pericarpium large, ovate, turbinate, one-seeded. There is only one species, *viz.* S. edule, the chocho vine It is a native of the West Indies; flowering and fruiting in December.

SECOND, in geometry, chronology, &c. the sixtieth part of a prime or minute; whether of a degree, or of an hour; it is denoted by two small accents, thus (″).

SECRETARY, an officer, who by his master's orders writes letters, despatches, and other instruments, which he renders authentic by his signet. Of these there are several kinds; as, 1. Secretaries of State, who are officers that have under their management and direction the most important affairs of the kingdom, and are obliged constantly to attend on the King; they receive and dispatch whatever comes to their hands, either from the crown the church, the army, private grants, pardons, dispensations, &c. as likewise petitions to the sovereign, which, when read, are returned to them; all which they dispatch according to the King's direction. They have authority to commit persons for treason, and other offences against the state, as conservators of the peace at common law, or as justices of

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the peace throughout the kingdom. They are members of the Privy Council, which is seldom or never held without one of them being present; and as to the business and correspondence in all parts of this kingdom, it is managed by either of the secretaries, without any distinction; but, with respect to foreign affairs, the business is divided into two provinces or departments, the southern and the northern, comprehending all the kingdoms and states that have any intercourse with Great Britain; each secretary receiving all letters and addresses from, and making all dispatches to, the several princes and states comprehended in his province. 2. Secretary of an Embassy, a person attending an ambassador for writing dispatches relating to the negotiation. There is a great difference between the secretary of an embassy, and the ambassador's secretary; the last being a domestic or menial of the ambassador, and the first a servant or minister of the prince. 3. The Secretary of War, an officer of the War Office, who has two chief clerks under him, the last of which is the secretary's messenger. There are also secretaries in most of the other offices.

SECRETION. In the course of the circulation the blood is conveyed to certain organs named glands, and is there entirely changed in its chemical composition, so as to form various products not pre-existing in the mass of blood, and which form some of the most important varieties of animal matter. See PHYSIOLOGY.

SECTION, in geometry, denotes a side or surface appearing of a body or figure cut by another; or the place where lines, planes, &c. cut each other. The common section of two planes is always a right line; being the line supposed to be drawn on one plane by the section of the other, or by its entrance into it.

SECTION *of a building*, in architecture, is the same with its profile; or a delineation of its heights and depths raised on a plane, as if the fabric was cut asunder to discover its inside.

SECTOR, in geometry, is a part of a circle comprehended between two radii and the arch; or it is a mixed triangle, formed by two radii and the arch of a circle.

SECTOR is also a mathematical instrument, of great use in finding the proportion between quantities of the same kind, as between lines and lines, surfaces and surfaces, &c. for which reason the French call it the compass of proportion.

The great advantage of the sector above common scales, &c. is, that it is adapted to all radii, and all scales. For, by the line of chords, sines, tangents, &c. on the sector, we have lines of chords, sines, tangents, &c. adapted to any radius between the length and breadth of the sector, when opened. The sector is founded on the fourth proposition of the sixth book of Euclid, where it is demonstrated, that similar triangles have their homologous sides proportional. See MATHEMATICAL INSTRUMENTS.

SECUNDINES, *after birth*, in anatomy, the several coats or membranes wherein the fœtus is wrapped up in the mother's womb, as the chorion and amnios, with the placenta, &c. See MIDWIFERY.

SECURIDACA, in botany, a genus of the Diadelphia Octandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx three-leaved; corolla papilionaceous, with the standard two-leaved within the wings; legume ovate, one-celled, one-seeded, ending in a ligulate wing. There are three species.

SEDUM, in botany, *stonecrop*, a genus of the Decandria Pentagynia class and order. Natural order of Succulentæ. Sempervivæ, Jussieu. Essential character: calyx five-cleft; corolla five-petalled; scales nectariferous, five, at the base of the germ; capsules five. There are thirty species, all of which are hardy, herbaceous, succulent perennials, durable in root, but mostly annual in stalk, &c. which, rising in spring, flower in June, July and August, in different sorts; the flowers consisting universally of five spreading petals, generally crowning the stalks numerously in corymbose and cymose bunches and spikes, appearing tolerably conspicuous, and are succeeded by plenty of seeds in autumn, by which they may be propagated; also abundantly by parting the roots, and by slips or cuttings of the stalks in summer: in all of which methods they readily grow, and spread very fast into tufted bunches: being all of succulent growth, they consequently delight most in dry soils, or in any dry rubbishy earth. As flowering plants, they are mostly employed to embellish rock-work, ruins, and the like places; planting either the roots or cuttings of the shoots in a little mud or any moist soil, at first placing it in the crevices, where they will soon root and fix themselves, and spread about very agreeably.

SEED, in botany, the essence of the fruit of every vegetable. Linnæus deno-

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minates it to be a deciduous part of the plant, containing the rudiments of the new vegetable, and fertilized by the sprinkling of the male dust. Plants are furnished with one seed, as the sea-pink; or two, as in umbelliferous plants; or three, as in the spurge; or many, as in the ranunculus, &c. The shape, structure, and sides of seeds are various. Linnæus denominates seeds the eggs of plants; and the fecundity of plants is often astonishing: there are 4,000 seeds in a single sun-flower: more than 30,000 in a poppy: and in a single tobacco plant 360,000 have been enumerated. The annual produce of a single stalk of spleenwort has been estimated to be a million of seeds. Plants are disseminated in various methods: some are carried along by rivers and torrents many hundred miles from their native soil, and cast upon a very different climate, to which, however, by degrees, they render themselves familiar. Some are formed by wings, to be borne before the wind to distant places Birds, squirrels, &c. swallow seeds, and void them whole and fit for vegetation, and thus disseminate them. There are others that disperse themselves by an elastic force, that resides either in the "calyx," as in oats and the ferns: in their "pappus," as in the "centaurea crupina," or in their capsule, as in the geranium.

SEED. See SEMEN.

SEGMENT *of a circle*, in geometry, that part of the circle contained between a chord and an arch of the same circle.

SEGMENT *of a sphere*, is a part of a sphere terminated by a portion of its surface, and a plane which cuts it off, passing somewhere out of the centre; being more properly called the section of a sphere. The base of such a segment, it is evident, is always a circle. And the convex surfaces of different segments are to each other as their altitudes or versed sines. And as the whole convex surface of the sphere is equal to four of its great circles, or four circles of the same diameter; so the surface of any segment is equal to four circles on a diameter equal to the chord of half the arc of the segment. So that if d denotes the diameter of the sphere, or the chord of half the circumference, and c the chord of half the arc of any other segment, also a the altitude or versed sine of the same; then,

$3.1416d^2$ is the surface of the whole sphere, and

$3.1416c^2$, or $3.1416d$ the surface of the segment.

For the solid content of a segment there are two rules usually given; *viz.* 1. To three times the square of the radius of its base, add the square of its height; multiply the sum by the height, and the product by .5236. Or, 2dly, From three times the diameter of the sphere, subtract twice the height of the frustrum; multiply the remainder by the square of the height, and the product by .5236.

SEGUIERIA, in botany, so named in honour of Jean Francois Seguier, a genus of the Polyandria Monogynia class and order. Essential character: calyx, five-leaved; corolla none; capsule, one-seeded, terminated by a large wing, having small lateral ones. There are two species, *viz.* S. Americana and S. Asiatica.

SEISIN, is two-fold, seisin in law, and seisin in fact. Seisin in fact, is when an actual possession is taken: seisin in law, when something is done, which the law accounts a seisin. See ESTATE, FEE, &c.

SELAGO, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Aggregatæ. Vitices, Jussieu. Essential character: calyx, five-cleft; corolla, tube capillary, border almost equal; seed one or two. There are twenty species. These plants are herbaceous or shrubby: all natives of the Cape of Good Hope. Leaves alternate; flowers in most of the species allied to those of eranthemum and verbena, irregular, tubular, in alternate terminating spikes, which are simple or manifold; in a few, the flowers are regular, with a short two-seeded tube, in a sort of terminating corymb

SELENITE, in mineralogy, a species of the calc genus, is of a snow white colour, passing into different shades of grey. It is most generally massive, and not unfrequently crystallized; the crystals are seldom large; internally, its lustre shining and splendent. The fracture is perfectly foliated. It is transparent, soft, and not particularly frangible; specific gravity 2.3: it is composed of lime, sulphuric acid, and water; and is found in Germany, France, and England. On account of its great purity it is employed in taking the most delicate impressions: it is also used for crayons, and when burnt and powdered, it is used for cleansing silver. It is the same with GYPSUM, under which word will be found some other particulars relating to it.

SELEUCIDÆ, in chronology. Æra of the Seleucidæ, or the Syro-Macedonian æra, is a computation of time, commencing

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from the establishment of the Seleucidæ, a race of Greek kings, who reigned, as successors of Alexander the Great, in Syria, as the Ptolemies did in Egypt. This æra we find expressed in the book of the Maccabees, and on a great number of Greek medals, struck by the cities of Syria, &c. The rabbins call it the æra of contracts; and the Arabs *therik dilkarnain*, that is, the æra of the two horns. According to the best accounts, the first year of this æra falls in the year 311 before Christ, being twelve years after Alexander's death.

SELINUM, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ or Umbelliferæ. Essential character: petals cordate, equal; involucre, reflex; fruit oval, oblong, compressed, flat, striated in the middle. There are nine species.

SELL, in building, is of two kinds, *viz.* ground-sell, which denotes the lowest piece of timber in a timber building, and that on which the whole superstructure is raised; and the window-sell is the bottom piece in a window-frame.

SEMECARPUS, in botany, a genus o the Pentandria Trigynia class and order. Essential character: calyx, inferior, five-cleft; corolla, five-petalled; nut, kidney-form, inserted into a large, fleshy, flattened receptacle. There is but one species, *viz.* S. anacardium, marking nut tree. It is a native of all the mountainous parts of India, flowering in July and August.

SEMEN. See PHYSIOLOGY Semen is secreted in the testes of male animals; but when it is ejected it is composed of two substances; the one is fluid and milky, and the other of a thick mucilaginous consistence, in which appear a great number of white, silky filaments, especially if it be agitated in cold water It has a disagreeable odour, and an acrid irritating taste. The specific gravity varies considerably, but is always greater than that of water When it is rubbed in a mortar, it froths up, and acquires the consistence of pomatum from the air with which it mixes It converts the flowers of violets to a green colour, and it precipitates the calcareous and metallic salts, which shows that it contains an uncombined alkali. The thick part of the semen, as it cools, becomes transparent, and assumes a greater degree of consistence; but it afterwards becomes entirely liquid, even without absorbing moisture from air. If semen be exposed to the air after it has become liquid at the temperature of sixty degrees, it becomes covered with a transparent pellicle, and at the end of three or four days deposits fine transparent crystals of a line in length, crossing each other like radii from a centre. When they are magnified, they appear to be four-sided prisms, terminated by long four-sided pyramids. When semen is exposed to a warm air, in considerable quantity, it is decomposed; it assumes the colour of the yolk of egg, and becomes acid, either by absorbing the oxygen from the atmosphere, or by a different combination and arrangement of its own constituent principles. Heat accelerates the liquefaction of semen; and when it has undergone this change, it is no longer susceptible of coagulation. It is decomposed by the application of strong heat. Water is first separated; it then blackens, swells up, and emits yellow fumes, having an empyreumatic, ammoniacal colour. A light coal remains behind, which burns readily to white ashes.

The acids readily dissolve semen, and this solution is not decomposed by the alkalies; nor indeed is the alkaline solution of semen decomposed by the acids. Wine, cider, and urine, also dissolve semen, but it is in consequence of the acid which is combined with these liquids. The crystals which form in semen by spontaneous evaporation in the open air, and which are entangled in the viscid matter, may be separated by adding water.

These crystals have neither smell nor taste They melt under the blow-pipe into a white opaque globule, which is surrounded with a yellowish flame This salt is insoluble in water, and is not acted on by the alkalies; but is soluble in the mineral acids without effervescence, from which solutions lime water, the alkalies, and oxalic acid, throw down a precipitate. The component parts of semen are found to be

Water	90
Mucilage	6
Soda	1
Phosphate of lime . .	3
	100

SEMICIRCLE, in geometry, half a circle, or that figure comprehended between the diameter of a circle and half the circumference.

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SEMICOLON, in grammar, one of the points or stops used to distinguish the several members of sentences from each other. See PUNCTUATION.

SEMICUBICAL *parabola*, in the higher geometry, a curve of the second order, wherein the cubes of the ordinates are as the squares of the abscisses. Its equation is $axx = y^3$.

The area of the space A P M (Plate XIV. Miscel. fig. 1.) is $= \frac{4}{15} x y = \frac{4}{15}$ A P $\times$ P M, or $\frac{4}{15}$ of the circumscribing rectangle. The content of the solid generated by the revolution of the space A P M about the axis A P, is $\frac{1}{2} p x y^2 =$ .7854 A P $\times$ P M^2, or $\frac{1}{2}$ of the circumscribing cylinder. And a circle equal to the surface of that solid may be found from the quadrature of an hyperbolic space. Also the length of any arc A M, of the curve may be easily obtained from the quadrature of a space contained under part of the curve of the common parabola, two semi-ordinates to the axis and the part of the axis contained between them. This curve may be described by a continued motion, *viz.* by fastening the angle of a square in the vertex of a common parabola; and then carrying the intersection of one side of this square and a long ruler (which ruler always moves perpendicular to the axis of the parabola) along the curve of that parabola. For the intersection of the ruler and the other side of the square will describe a semicubical parabola. Maclaurin performs this without a common parabola, in his Geometria Organica.

SEMIDIAMETER, half the diameter, or a right line drawn from the centre of a circle, or sphere, to its circumference; being the same with what is otherwise called the radius. The distances, diameters, &c. of the heavenly bodies, are usually estimated, by astronomers, in semidiameters of the earth; and the distances of the secondary planets from their respective primary ones, by semidiameters of the body of the primary planet.

Suppose the semidiameter of the earth to be unity, then the measures of the sun and planets will be as follow: the semidiameter of

The Earth	1
The Sun	111 25
The Moon	0.27
Mercury	0.38
Venus	1.15
Mars	0 65
Jupiter	11.81
Saturn	9.77
Herschel	4.32

SEMIPARABOLA, in geometry, a curve defined by the equation $ax^{m-1} = y^m$; as $ax^2 = y^3$, and $ax^3 = y^4$. In semiparabolas, $y^m : v^m :: ax^{m-1} : a z^{m-1} = x^{m-1} : z^{m-1}$, or the powers of the semiordinates are as the powers of the semiabscisses one degree lower; for instance, in cubical semiparabolas the cubes of the ordinates are as the squares of the abscisses: that is, $y^3 : v^3 :: x^2 : z^2$.

SEMPERVIVUM in botany, *houseleek*, a genus of the Dodecandria Polygynia class and order. Natural order of Succulentæ Sempervivæ, Jussieu. Essential character: calyx twelve-parted; petals twelve; capsule twelve, many-seeded. There are fourteen species.

SENECIO, in botany, *groundsel*, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx cylindrical, calycled, with the scales mortified at the tip; down simple: receptacle naked. There are seventy-five species.

SENSATION. The brain is a soft pulpy mass, of a whitish colour on the inside, occupying all the cavity of the skull. Minute differences are observable in the substance of the brain in different parts of it, but it is unnecessary to enter upon a statement of them here. (See ANATOMY.) The spinal marrow is the continuation of the lowest part of the brain, which passes through the great opening of the skull down the hollow of the back-bone. The substance contained in the hollow of the backbone is the same with that in the cavities of the skull; and it is sometimes convenient to comprehend both the portions under the same general name of brain. From the brain proceeds the nerves, which at first are fine fibres, of the same substance with the brain: these fibres meet, and form soft white pulpy cords, which afterwards spread themselves over various parts of the body, by splitting into innumerable and exceedingly minute branches. Anatomists count forty pairs of nerves, (for they come off in pairs, though they afterwards separate,) and of those nine or ten only come from the brain at the bottom of the skull, and the rest from the spinal marrow. Those from the brain are distributed to various parts of the head: those from the spinal marrow are distributed over the trunk and extremities. The external organs of sense, the nerves, and the brain, are the organs of sensation. All, as we are at present constituted, are necessary to sensation. If the external organ is

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destroyed, no sensation can be produced: where there are no nerves, there is no sensation: where the nervous branches are most numerous, there is most sensation: if the nerve be destroyed, sensation cannot be produced from those parts to which the nerve belongs, which are further from the brain than the injured parts. The brain is the ultimate organ of sensation of which we have any knowledge. All the nerves terminate in the brain. If the brain is compressed, sensation is suspended. If the brain is considerably injured, sensation ceases.—So, also, there is considerable reason to believe that the brain is the immediate organ of ideas. If the brain is diseased, many of the phenomena of thought are altogether changed; if the brain is compressed, thought is suspended; if the brain is injured, ideas cease.—So, also, the brain appears to be the ultimate organ of all motions which are not produced by the immediate action of external objects upon the muscles. The muscles are the immediate organs of motion. The muscles consist of fleshy substances, and sometimes of tendons. The tendons fasten the muscles to the bones; and the fleshy part by its contractions produces the motions of the bones. Into the fleshy parts of the muscles numerous nerves enter; they are diffused over its surface and within its substance. These nerves, as before mentioned, terminate in the brain either of the head or back. They are the intermediate organs of voluntary motion between the brain and the muscles. If a nerve be compressed or punctured, motion is produced in the muscle over which that nerve is distributed. If a portion of a nerve be cut, or otherwise destroyed, voluntary motion can no longer be produced in that muscle over which it was distributed. If the brain be touched with any instrument or caustic, applied to it, the muscular system undergoes the most violent contortions. If the spinal marrow be pierced with a probe, all the muscles of the trunk and limbs undergo violent contortions, particularly those of the back. If the brain be compressed, the whole body becomes paralysed, and the power of voluntary motion is suspended. If the spinal marrow be compressed, the power of voluntary motion is suspended in those muscles which receive their nerves from the back. If the brain is considerably injured, all power of voluntary motion ceases.

The external organs of sense are usually classed under five heads, those of sight, of hearing, of feeling, of smell, and of taste. The sense of feeling might probably be divided with convenience into two or three, because the classes of sensations, which are referred to this sense, differ considerably in themselves and in the external causes producing them. But the common arrangement is sufficient for our purpose.

By the law of association, many ideas received directly from sensible objects, through the medium of different senses, become connected, and at last blended together, so as to form one very complex, though apparently uncompounded, idea; and this complex idea is often recalled to the mind by a corresponding sensation, and, by association, becomes so connected with that sensation, that the complex idea itself is often mistaken for a part of the sensation. For instance, the sensation produced by the impression made by a globe on the sense of sight is, as can be proved, nothing more than that produced by a circle, with certain variations of light and shade; yet, immediately on the sensation being perceived, the ideas of its solidity, of its hardness, its magnitude, and of its being something external to one's self, (all of which have been derived from the sense of touch, in connection with this object, or others in some respect similar), immediately rise up in the mind in one blended form; by their complete coalescence they appear to be one, and by their immediate and constant connection with the sensation, they appear to the mind as a part of the sensation. Indeed, there are comparatively few people, who ever think that the sensation derived from the sight is nothing more than that derived from a minute picture delineated on the back part of the eye, called the retina. Things appear to us, at one glance of the sight, to be solid or flat, to be near or distant, to be large or small, to be conjoined with other things, or separate from them, to be parts of our own frame, or external to it, &c. and all this we appear to learn by the sight alone; but the fact is, that all these ideas are derived from another sense, at various times, and altogether blending together, and arising the moment the visible impression is communicated, they appear part of the visible impression. "The visible appearance of objects," as Berkeley observes, "is a kind of language, serving to inform us of their distance, magnitude and figure;" no sooner are these signs presented to the mind, than with the rapidity of lightning the ideas associated with them succeed, and appear to have been communi-

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cated by the sight, and to be in reality a part of the sensation.

The sensation thus connected with the complex idea is a perception. The accuracy and vividness of the sensation depend entirely upon the sensitive power and its organs: the accuracy and vividness of the perception depend partly upon the accuracy and vividness of the component sensations, and partly upon the activity and energy of the retentive and associative powers.

For a somewhat particular account of each sense, with statements respecting the share each has in forming our ideas, *i. e.* our notions and our feelings, we beg our readers to refer in this place to the following articles, in the order in which we here detail them; SIGHT, TOUCH, TASTE, SMELL, and SOUND; and presuming upon the perusal of those articles, we shall here make a few general observations respecting sensations.

1. Sensations are the rudiments and elements of all our ideas; that is, of all our thoughts and feelings. This is a position, which perhaps few of those who are unacquainted with the speculations of metaphysical writers would suppose to have been ever doubted. When an infant enters into the world, there is no appearance of any ideas being in its mind; and no one can doubt that if any human being could be deprived of all his organs and sensations, before any sensations had been received, that he would never have ideas. Yet it was once generally believed, that there are in ever human being ideas born with him, which were called innate. What they were, or in what respects they differed from those which are indisputably received by means of the organs of sensation, was never, we apprehend, pointed out. Indeed, the doctrine of innate ideas rests merely on an appeal to ignorance; and as soon as any probable account of their origin is given, all support of it falls at once. Before the grand law of association was tolerably understood, the mode of the formation of many complex ideas could not be satisfactorily ascertained; and it must still be admitted, that we cannot in all cases fully trace the formation of our complex ideas; but we can in a sufficient number to decide the point. Between those whose formation we can explain, and those whose we cannot, there is no further difference, than our greater or less acquaintance with the individual steps of the process.

2. In the earliest exercise of the sensitive power, sensations are simple, uncompounded with the relics of former corresponding sensations; but the sensations very soon become perceptions, that is, they instantaneously recal the relics of other corresponding sensations. This implies the exercise of the retentive and associative power; but as perceptions are almost uniformly produced by every exercise of the sensitive power, it may be proper to speak of them here in connection with sensations. That sensations in a somewhat advanced state of mental culture are usually perceptions, any person may satisfy himself, by considering, that sensations are usually accompanied either with an idea of an external object causing them, or (if they are thereby the effect of the state of the bodily system) with an idea of the sensation being in the part of the body in which the cause of the sensation exists; both of which are complex ideas, formed from a great number of impressions, and which could in no instance be produced by any exertion of the sensitive power. —We, therefore, in many cases, without any impropriety, speak of perceptions and sensations indiscriminately; since a perception always implies a sensation, and sensations most frequently are perceptions; and accordingly we shall find, in some writers, that they are confounded sometimes where they ought to be kept distinct.

3. Considering man as an intellectual being, the accuracy and extent of his perceptions are of the first moment. They are, in fact, the materials of all knowledge respecting external objects, and in the early stages of mental culture are the only objects of the understanding. Now the accuracy and extent of the perception depends upon the vividness and efficaciousness of the component sensations, and the number of them received from the same or similar objects in different situations, and through the medium of different senses. The object, therefore, of the early education of the human being should be, to invigorate the organs of sense. Independently of the effects of the general healthiness of the system, it appears decidedly probable, that the organs of sense are capable of being improved by exercise. It is the grand law of our frame, that moderate exertion increases the power of exertion; and assuredly there are facts which lead to the same conclusion in this particular case. But this may be safely left to the natural effect of exertion. All that is to be done is, to afford children the opportunity of exercising their senses on a va-

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riety of objects, and as much as possible in a variety of situations. Some have supposed that the senses are not capable of improvement. We readily grant, that the superiority possessed by some over others, in the use of their senses, principally consists in the extent, and accuracy, and vigour of their perceptions. Two persons, with equally good eyes, will see the same thing very differently, will have very different perceptions, though the sensations cannot as far as we can judge, differ in any respect. Let two such persons have a watch placed before each of them, as nearly as possible in the same situation in every respect; suppose one minutely acquainted with the beautiful machine and the other unacquainted with it; they have the same sensations, but how different their perceptions; one sees a number of movements, of which he cannot discern the connection, nor point out the part it bears in the performance of the object; the other at once perceives the mutual dependence of the parts, and the minutiæ of the whole structure, its excellencies and defects, &c. Our limits will not permit further illustration, but it is in the power of every one to trace it for themselves, by recollecting how differently the same thing appears to different persons of equally vigorous powers of sensation, and how differently it appears to the same person at different times. But all these things do not disprove what we before stated respecting the improvement of the senses themselves; they merely point out, as another means to render sensation efficacious, that we should extend the perceptions, and render them accurate. This is, by giving extent and accuracy to the perceptions, we render the sensations more efficacious, which we mentioned as one of the principal things upon which the extent and accuracy of the perceptions depend. To give vividness and efficacy to the sensations, the organs of sense should then be exerted on various objects and in various situations; a still more important mean is, to direct the attention sufficiently to the objects of sensation. In what manner it produces the effect we know not, but it is certain that the efficaciousness of sensations in producing distinct ideas depends principally upon the degree of attention which those sensations receive. Hence, those who have the care of infants and children should give them every opportunity to keep their attention directed to the objects of their senses, and every means should be employed to lead them to such attention: a child intently gazing upon an object, or examining it with its little hands and lips, is as usefully employed in the cultivation of intellect as the fondest parent can wish. There is, however, more to be done in this connection, also, by allowing the child full scope for its own exertions, than by any direct efforts which can be made by others. When its attention is fixed, let it remain so; if possible, let the objects of sense be brought under different aspects, and exposed to the different senses. Before words become to a child the sign of voluntary action, all that can be done is, to expose it to sensations, and to allow them to fix the attention: but afterwards more direct efforts may be made, and the attention may be fixed by various other means than the mere action of the sensations themselves. Independently of its value in providing materials for clear perceptions, it is of peculiar importance to the future improvement of the understanding, and consequently to the moral culture, that the habit of fixed attention should be acquired; and we wish here to express our decided opinion, that the character of the intellect and affections, however much it may be modified by future cultivation, receives its stamp from the employment of the first few years of life; that the education of the nursery is of almost incalculable moment in the mental and moral culture; that by neglect of it, years of labour may be rendered requisite to compensate in some degree for it, and by a proper attention to it, a foundation is laid for a clear and vigorous understanding, and lively and pure affections. As far as the understanding can be considered as separate from the affections, the primary object is, to gain clear and extensive perceptions, and fixed active attention; and respecting these the few observations which have been made may afford some useful hints to the thoughtful. Miss Hamilton has many judicious remarks on this subject, at the beginning of the second volume of her work on education; a work, which, though sometimes incorrect as to scientific arrangement, and still more frequently as to precision of language, contains many highly valuable instructions for the culture of the human mind.

4. Sensations are to be considered, not only as the original materials for the various operations of intellect, but as the sources of all the mental pleasures and pains. In the earliest periods of life, probably there is no sensation unaccompanied either with pleasure or with pain; and as man is constituted, this is neces-

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sary, both to fix the attention upon the objects of sense, and for self-preservation. Pleasurable sensations are called sensible pleasures, painful sensations sensible pains. The pleasurable sensations leave behind them pleasurable ideas, which are called mental or intellectual pleasures; and in the same manner the painful sensations leave behind them painful ideas, which are called mental pains. Mental pleasures combine with one another, and form more complex feelings, and these with others, and so on till, owing to the very great complexity of the whole, the component parts are not discernible. In this stage of their progress it is that they generally fall under our inspection. They appear to us at first to have no connection with sensations; but this is merely because we cannot readily separate them into their component parts. Reasonable evidence can be adduced to show, that all the mental pleasures and pains have their origin, indeed are formed solely of the relics of sensible pleasures and pains.

5. Considering sensible pleasures and pains as the rudiments of mental pleasures and pains, it is requisite, during the early part of life, to keep the inlets of sensation in a fit state for receiving them, and not to check the one, or to impose the other, except where an enlightened regard to the future welfare requires it. The health of the body should be attended to, not merely as a means of present and future sensible enjoyment, but as increasing the fund of materials for the purest mental pleasures. Childhood should be regarded as the time for the acquisition of materials, not only for the intellect, but for the affections. Its pleasures should be restrained only by those limits which the laws of sensation and association impose; which require that they should be moderate, and connected only with such objects as will not lead to future pains: its unavoidable pains should, as far as possible, be removed; and no avoidable ones imposed, except what the laws of association require, that is, those which are necessary for the removing or preventing of greater evil, either by remedying bodily disorders, and destroying false associations, or by connecting sensible pains with such objects as would lead to future pains, more important either as to vividness or duration.

6. The grand law of sensible pleasures and pains is, that by frequent repetition they lose their vividness. This is a law, to which may be traced various important facts connected with the moral culture. Whatever be the peculiar mode by which impressions from the objects of sense are transmitted through the nerves to the brain, it seems decidedly probable, that the difference between pleasurable and painful sensations consists (as far as respects the sensations themselves) in degree only: that pain has the same cause as pleasure, except that it acts more intensely. "All pleasure," as Hartley remarks, "appears to pass into pain by increasing its cause, impression, duration, sensibility of the organ upon which it is impressed, &c.: thus an agreeable warmth may be made to pass into a troublesome or burning heat, by increase or continuance; and the same thing holds with respect to friction, light, and sound." Hence, since repetition diminishes the vividness of the sensation, (provided there be no increase in the exciting cause, or in the sensibility of the organ, &c.) great pain will by repetition gradually subside into pain less intense; pains may be converted by repetition into pleasures, and pleasures may be converted into indifferent sensations. This progress may be observed in the effects of spirituous liquors, or any other stimuli, which strongly affect the organs of taste. There are probably no cases in which the taste of spirituous liquors would originally be otherwise than disagreeable; by degrees the repeated use of them brings the sensations which they occasion within the limit of pleasure; even then a considerable increase of the quantity taken would heighten the sensations to the limits of pain; but suppose the pleasurable portion continued without increase, the repeated use of it diminishes the vividness of the pleasure, till at last the sensation produced is completely indifferent.—We here adduce the fact merely as illustrative of the general principle.

7. We have stated, in the separate articles above referred to, that the original sensible pleasures derived from the taste and smell are very numerous, and far exceed the pains; that the original sensible pleasures derived from the sight and the hearing are also numerous, while the original sensible pains are few; and that the original sensible pleasures derived from the sense of feeling are less intense than the pains derived from that sense, which are more numerous and vivid than all the other sensible pains united. From this account we should be led to infer, that the pains of sensation are very far exceeded by the pleasures of sensation.—

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This will be still more evident, when we recollect that the pleasurable sensations are those of constant occurrence: the painful sensations much more rare. In the early part of life, most sensations that are not painful are pleasurable; and the pleasurable are continually recurring. The eye and the ear seem to convey scarcely any thing but pleasurable sensations to the infant mind; the taste and smell are continually pouring in their pleasurable sensations, seldom mixed with pain; the feeling, when the body is healthy, "when life is felt in every limb," is also constantly adding to the stock of pleasurable sensations, those derived from the glow of health and the active motions of childhood; to balance all this, there are, in some few cases, frequent pains of body; but more frequently the pains arising from ill health, are of seldom recurrence, and the artificial sensible pains are still less frequently received. Such is the matter of fact; and if we consider the cause of the sensible pleasures and pains as differing only in degree, we shall readily admit, that, on the whole, the pleasurable sensations very far exceed the painful sensations; for the sensible pains being produced by an excessive action of the organs of sensation, common impressions will not produce them, and should they become very frequent, by the grand law of sensation, already stated, they will gradually diminish in vividness, and at last come within the limits of pleasure.

SENSITIVE *plant*. See MIMOSA.

SENTICOSÆ, in botany, the name of the thirty-fifth order in Linnæus's Fragments of a Natural Method, consisting of the rose, bramble, and other plants that resemble them in external structure.

SEPIA, in natural history, *cuttle-fish*, a genus of the Vermes Mollusca class and order. Body fleshy, receiving the breast in a sheath, with a tubular aperture at its base; eight arms, beset with numerous warts or suckers, and in most species two pedunculated tentacula; head short; eyes large; mouth resembling a parrot's beak. Eight species are mentioned. They inhabit various seas, and in hot climates grow to a very considerable size; they are armed with a most terrible apparatus of holders, furnished with suckers, by which they fasten upon and convey their prey to the mouth.

S. octopus is found in the Mediterranean and Indian Seas, and in the latter it is sometimes so large that the arms are said to be nine fathoms long. In these seas the Indians never venture out without hatchets in their boats, to cut off the arms, should it attempt to fasten upon them and draw them under water.

S. officinalis inhabits the ocean, and is the prey of the whale tribe and plaise; its arms are also frequently eaten off by the conger-eel, and are reproduced. See REPRODUCTION. The bony scale on the back is that which is sold in the shops, and which, when reduced to fine powder, is reckoned excellent for the teeth, as well for keeping them white as for preserving them. It is also used as pounce. These animals have the power of squirting out a black fluid resembling ink, which is said to be an ingredient used in the composition of Indian ink. They deposit their eggs upon sea-weed, which resemble a bunch of grapes. When first deposited they are white, but when impregnated by the male they become black; they are round, with a little point at the end, and in each of them is inclosed a living cuttle-fish, surrounded with a gelatinous fluid. The flesh is used as food by the Italians.

SEPIARIÆ, in botany, the name of the forty-fourth order in Linnæus's Fragments of a Natural Method, consisting of many beautiful woody plants, both of the shrub and tree kind, most of which do not drop their leaves till nearly the time in which the new leaves begin to appear. Among the plants of this order are the fraxinus, or ash; jasminum, jessamine tree; ligustrum, privet; syringa, lilac.

SEPTAS, in botany, a genus of the Heptandria Heptagynia class and order. Natural order of Succulentæ. Sempervivæ, Jussieu. There is but one species, *viz.* S. capensis, round-leaved septas, a native of the Cape of Good Hope.

SEPTEMBER, the ninth month of the year, consisting of only thirty days: it took its name as being the seventh month reckoning from March, with which the Romans began their year.

SEPTUAGINT, the name given to a Greek version of the books of the Old Testament, from its being supposed to be performed by seventy-two Jews, who are usually called the seventy interpreters, because seventy is a round number. The history of this version is expressly written by Aristeas, an officer of the guards to Ptolemy Philadelphus, the substance of whose account is as follows: Ptolemy having erected a fine library at Alexandria, which he took care to fill with the most curious and valuable books from all parts of the world, was informed that the Jews had one containing the laws

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of Moses, and the history of that people, and being desirous of enriching his library with a Greek translation of it, applied to the high priest of the Jews; and, to engage him to comply with his request, set at liberty all the Jews, whom his father Ptolemy Soter had reduced to slavery. After such a step, he easily obtained what he desired; Eleazar, the Jewish high-priest, sent back his embassadors with an exact copy of the Mosaical law, written in letters of gold, and six elders of each tribe, in all seventy-two, who were received with marks of respect by the king, and then conducted into the Isle of Pharos, where they were lodged in a house prepared for their reception, and supplied with every thing necessary in abundance. They set about the translation without loss of time, and finished it in seventy-two days; and the whole being read in the presence of the king, he admired the profound wisdom of the laws of Moses, and sent back the deputies, laden with presents for themselves, the high-priest, and the temple. This version was in use to the time of our Saviour, and is that out of which all the citations in the New Testament, from the Old, are taken. It was also the ordinary and canonical translation made use of by the Christian church in the earliest ages; and it still subsists in the churches both of the east and west. It is, however, observable, that the chronology of the septuagint is different from the Hebrew text.

SEQUENCE, in gaming, a set of cards immediately following each other, in the same suit, as a king, queen, knave, &c. and thus we say, a sequence of three, four, or five cards; but at piquet these are called tierces, quarts, quints, &c.

SEQUESTRATION, is the separating or setting aside of a thing in controversy from the possession of both those who contend for it; and it is of two kinds, voluntary or necessary: voluntary is that which is done by consent of each party; necessary is what the judge does of his authority, whether the parties will or not. It is used also for the act of the ordinary disposing of the goods and chattels of one deceased, whose estate no man will meddle with. A sequestration is also a kind of execution for debt, especially in the case of a beneficed clerk, or the profits of the benefice, to be paid over to him that had the judgment till the debt is satisfied.

SEQUIN, a gold coin struck at Venice, and in several parts of the Grand Seignior's dominions.

SERAPIAS, in botany, *helleborine*, a genus of the Gynandria Diandria class and order. Natural order of Orchideæ. Essential character: nectary ovate, gibbous, with an ovate lip. There are fourteen species.

SERGE, in commerce, a woollen stuff manufactured in a loom, of which there are various kinds, denominated either from their different qualities, or from the places where they are wrought; the most considerable of which is the English serge, which is highly valued abroad, and of which a manufacture had been for some years carried on in France.

In the manufacture of serges, the longest wool is chosen for the warp, and the shortest for the woof. But before either kind is used, it is first scoured, by putting it in a copper of liquor, somewhat more than lukewarm, composed of three parts of fair water and one of urine. After it has staid in it long enough for the liquor to take off the grease, &c. it is stirred briskly about with a wooden peel, taken out, drained, washed in a running water, and dried in the shade; beaten with sticks on a wooden rack, to drive out the coarser dust and filth; and then picked clean with the hands. It is then greased with oil of olives, and the longest wool combed with large combs, heated in a little furnace for that purpose: to clear it from the oil, it is put into a vessel of hot soap-water, whence being taken out, wrung, and dried, it is spun on the wheel. As to the shorter wool, intended for the woof, it is only carded on the knee with small fine cards, and then spun on the wheel, without being scoured of its oil; and here it is to be observed, that the thread for the warp is always to be spun finer, and much better twisted, than that of the woof.

The wool both for the warp and woof being spun, and the thread reeled into skeins, that of the woof is put on spools, fit for the cavity of the shuttle; and that for the warp is wound on a kind of wooden bobbins, to fit it for warping; and when warped, it is stiffened with a size, usually made of the shreds of parchment; and, when dried, put into the loom, and mounted so as to be raised by four treadles, placed under the loom, which the workman makes to act transversely, equally, and alternately, one after another, with his feet; and as the threads are raised, throws the shuttle. See WEAVING.

The serge, on being taken from the loom, is carried to the fuller, who fulls or scours it, in the trough of his mill, with

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fuller's earth; and after the first fulling, the knots, ends, straws, &c. sticking out on either side of the surface, are taken off with a kind of pliers, or iron pincers, after which it is returned into the fulling-trough, where it is worked with warm water, in which soap has been dissolved; when quite cleared, it is taken out, the knots are again pulled off; it is then put on the tenter to dry, taking care, as fast as it dries, to stretch it out, both in length and breadth, till it be brought to its just dimensions; then being taken off the tenter, it is dyed, shorn, and pressed.

SERJEANT *at law*, is the highest degree taken in that profession, as that of a doctor is in the civil law. To these serjeants, as men of great learning and experience, one court is set apart for them to plead in by themselves, which is the Court of Common Pleas, where the common law of England is most strictly observed; yet, though they have this court to themselves, they are not restrained from pleading in any other courts. The judges cannot be elevated to that dignity till they have taken the degree of Serjeant at Law. They are called brothers by the judges, who hear them next to the King's counsel; but a King's Serjeant has precedence of all but the Attorney and Solicitor General. They are made by the King's mandate or writ.

SERJEANT *at arms*, is one whose office is to attend on the person of the King, to arrest persons of condition offending.

SERJEANTY, in law, signifies a service that cannot be due from a tenant to any Lord, but to the King only. Although the old tenures are abolished, yet the merely honorary services of grand and petit serjeanty remain.

SERIES, in general, denotes a continued succession of things in the same order, and having the same relation or connection with each other: in this sense we say, a series of Emperors, Kings, Bishops, &c.

In natural history, a series is used for an order or subdivision of some class of natural bodies; comprehending all such as are distinguished from the other bodies of that class by certain characters, which they possess in common, and which the rest of the bodies of that class have not.

SERIES, in mathematics, is a number of terms, whether of numbers or quantities, increasing or decreasing in a given proportion; the doctrine of which has already been given under the article PROGRESSION.

SERIES, *infinite*, is a series consisting of an infinite number of terms, that is, to the end of which it is impossible ever to come; so that let the series be carried on to any assignable length, or number of terms, it can be carried yet further, without end, or limitation.

A number actually infinite, (that is, all whose units can be actually assigned, and yet is without limits,) is a plain contradiction to all our ideas about numbers; for whatever number we can conceive, or have any proper idea of, is always determinate, and finite; so that a greater after it may be assigned, and a greater after this; and so on, without a possibility of ever coming to an end of the addition or increase of numbers assignable; which inexhaustibility, or endless progression, in the nature of numbers, is all we can distinctly understand by the infinity of number; and therefore to say, that the number of any things is infinite, is not saying that we comprehend their number, but indeed the contrary; the only thing positive in this proposition being this, that the number of these things is greater than any number which we can actually conceive and assign. But then, whether in things that do really exist, it can be truly said that their number is greater than any assignable number; or, which is the same thing, that in the numeration of their units, one after another, it is impossible ever to come to an end; this is a question about which there are different opinions, with which we have no business in this place; for all that we are concerned here to know is this certain truth, that, after one determinate number we can conceive a greater, and after this a greater, and so on without end. And, therefore, whether the number of any things that do or can really exist all at once can be such, that it exceeds any determinable number, or not, this is true, that of things which exist, or are produced successively one after another, the number may be greater than any assignable one; because, though the number of things thus produced, that does actually exist at any time, is finite, yet it may be increased without end. And this is the distinct and true notion of the infinity of a series, that is, of the infinity of the number of its terms, as it is expressed in the definition.

Hence it is plain that we cannot apply to an infinite series the common notion of a sum, *viz.* a collection of several particular numbers that are joined and added together one after another; for this sup-

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poses that these particulars are all known and determined; whereas the terms of an infinite series cannot be all separately assigned, there being no end in the numeration of its parts, and therefore it can have no sum in sense. But again, if we consider that the idea of an infinite series consists of two parts, *viz.* the idea of something positive and determined, in so far as we conceive the series to be actually carried on: and the idea of an inexhaustible remainder still behind, or an endless addition of terms that can be made to it one after another, which is as different from the idea of a finite series as two things can be: hence we may conceive it as a whole of its own kind, which, therefore, may be said to have a total value, whether that be determinable or not. Now in some infinite series this value is finite or limited; that is, a number is assignable, beyond which the sum of no assignable number of terms of the series can ever reach, nor indeed ever be equal to it, yet it may approach to it in such a manner as to want less than any assignable difference; and this we may call the value or sum of the series; not as being a number found by the common method of addition, but as being such a limitation of the value of the series, taken in all its infinite capacity, that if it were possible to add them all, one after another, the sum would be equal to this number.

Again, in other series the value has no limitation; and we may express this, by saying the sum of the series is infinitely great: which, indeed, signifies no more than that it has no determinate and assignable value; and that the series may be carried such a length as its sum, so far, shall be greater than any given number. In short, in the first case, we affirm there is a sum, yet not a sum taken in the common sense; in the other case, we plainly deny a determinate sum in any sense.

Theorem 1. In an infinite series of numbers, increasing by an equal difference or ratio (that is, an arithmetical or geometrical increasing progression) from a given number, a term may be found greater than any assignable number.

Hence, if the series increase by differences that continually increase, or by ratios that continually increase, comparing each term to the preceding, it is manifest that the same thing must be true, as if the differences or ratios continued equal.

Theorem 2. In a series decreasing in infinitum, in a given ratio, we can find a term less than any assignable fraction.

Hence, if the terms decrease, so as the ratios of each term to the preceding do also continually decrease, then the same thing is also true, as when they continue equal.

Theorem 3. The sum of an infinite series of numbers, all equal, or increasing continually, by whatever differences or ratios, is infinitely great; that is, such a series has no determinate sum, but grows so as to exceed any assignable number.

Demons. First, if the terms are all equal, as A : A : A, &c. then the sum of any finite number of them is the product of A by that number, as A n; but the greater n is, the greater is A n; and we can take n greater than any assignable number, therefore A n will be still greater than any assignable number.

Secondly, suppose the series increases continually, (whether it do so infinitely or limitedly,) then its sum must be infinitely great, because it would be so if the terms continued all equal, and therefore will be more so, since they increase. But if we suppose the series increases infinitely, either by equal ratios or differences, or by increasing differences or ratios of each term to the preceding; then the reason of the sums being infinite will appear from the first theorem; for, in such a series, a term can be found greater than any assignable number, and much more: therefore the sum of that and all the preceding.

Theorem 4. The sum of an infinite series of numbers decreasing in the same ratio is a finite number, equal to the quote arising from the division of the product of the ratio and first term, by the ratio less by unity; that is, the sum of an assignable number of terms of the series can never be equal to that quote; and yet no number less than it is equal to the value of the series, or to what we can actually determine in it; so that we can carry the series so far, that the sum shall want of this quote less than any assignable difference.

Demons. To whatever assigned number of terms the series is carried, it is so far finite; and if the greatest term is l, the least A, and the ratio r, then the sum is $S = \frac{r\,l - A}{r - 1}$. See PROGRESSION.

Now, in a decreasing series from l, the more terms we actually raise, the last of them A, becomes the lesser, and the lesser A is $r\,l$ — A is the greater, and so al-

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so is $\frac{rl - A}{r-1}$: but $rl - A$ being still less than rl, therefore $\frac{rl - A}{r-1}$ is still less than $\frac{rl}{r-1}$, that is, the sum of an assignable number of terms of the series is still less than the quote mentioned, which is $\frac{rl}{r-1}$, and this is the first part of the theorem.

Again, the series may be actually continued so far, that $\frac{rl - A}{r-1}$ shall want of $\frac{rl}{r-1}$ less than any assignable difference; for, as the series goes on, A becomes less and less in a certain ratio, and so the series may be actually continued till A becomes less than any assignable number, (by Theorem 2,) now $\frac{rl}{r-1} - \frac{rl - A}{r-1} = \frac{A}{r-1}$, and $\frac{A}{r-1}$ is less than A; therefore let any number assigned be called N, we can carry the series so far till the last term A be less than N; and because $\frac{rl - A}{r-1}$ wants of $\frac{rl}{r-1}$, the difference $\frac{A}{r-1}$, which is less than A, which is also less than N, therefore the second part of the theorem is also true, and $\frac{rl}{r-1}$ is the true value of the series.

Scholium. The sense in which $\frac{rl}{r-1}$ is called the sum of the series has been sufficiently explained; to which, however, we shall add this, that whatever consequences follow from the supposition of $\frac{rl}{r-1}$ being the true and adequate value of the series taken in all its infinite capacity, as if the whole were actually determined and added together, can never be the occasion of any assignable error in any operation or demonstration where it is used in that sense: because, if it is said that it exceeds that adequate value, yet it is demonstrated that this excess must be less than any assignable difference, which is in effect no difference, and so the consequent error will be in effect no error: for if any error can happen from $\frac{rl}{r-1}$ being greater than it ought to be, to represent the complete value of the infinite series, that error depends upon the excess of $\frac{rl}{r-1}$ over that complete value; but this excess being unassignable, that consequent error must be so too; because still the less the excess is, the less will the error be that depends upon it. And for this reason we may justly enough look upon $\frac{rl}{r-1}$ as expressing the adequate value of the infinite series. But we are further satisfied of the reasonableness of this, by finding, in fact, that a finite quantity does actually convert into an infinite series, which happens in the case of infinite decimals. For example, $\frac{2}{3} = .6666$, &c. which is plainly a geometrical series from $\frac{6}{10}$ in the continual ratio of 10 to 1; for it is $\frac{6}{10} + \frac{6}{100} + \frac{6}{1000} + \frac{6}{10000}$, &c.

And reversely, if we take this series, and find its sum by the preceding theorem, it comes to the same $\frac{2}{3}$; for $l = \frac{6}{10}$, $r = 10$, therefore $rl = \frac{60}{10} = 6$; and $r - 1 = 9$; whence $\frac{rl}{r-1} = \frac{6}{9} = \frac{2}{3}$.

We have added here a table of all the varieties of determined problems of infinite, decreasing geometrical progressions, which all depend upon these three things, *viz.* the greatest term l, the ratio r, and the sum S; by any two of which the remaining one may be found: to which we have added some other problems, wherein S — L is considered as a thing distinct by itself, that is, without considering S and L separately.

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Given.	Sought.		Or supposing the ratio $\frac{a}{b}$ or the second term to be M, where-	Solutions.
rl	s,	$s = \frac{rl}{r-1}$	by the ratio is $\frac{l}{M}$, then is	$s = \frac{a}{a-b}$ of $l = \frac{l^2}{l-M}$
rs	l,	$l = \frac{s \times \overline{r-1}}{r}$		$l = \frac{a-b}{a}$ of $s = \frac{\overline{l-M} \times s}{l}$
ls	r,	$r = \frac{}{s-l}$		$s - l = \frac{b}{a-b}$ of $l = \frac{Ml}{l-M}$
lr	$s-l$,	$s - l = \frac{l}{r-1}$		
sr	$s-l$,	$s - l = \frac{s}{r}$		$s - l = \frac{b}{a}$ of $s = \frac{Ms}{l}$
$r.\ s-l$	s, l	$s = \overline{s-l} \times r$, $l = \overline{s-l} \times \overline{r-1}$		$s = \frac{a}{b}$ of $s - l = \frac{l \times \overline{s-l}}{M}$; $l = \frac{a-b}{b}$ of $s - l = \frac{\overline{l-M} \times \overline{s-l}}{M}$

Theorem 5. In the arithmetic progression 1, 2, 3, 4, &c. the sum is to the product of the last term, by the number of terms, that is, to the square of the last term, in a ratio always greater than 1 : 2, but approaching infinitely near it. But if the arithmetical series begins with 0, thus, 0, 1, 2, 3, 4, &c. then the sum is to the product of the last term, by the number of terms, exactly in every step as 1 to 2.

Theorem 6. Take the natural progression, beginning with 0, thus, 0, 1, 2, 3, &c. and take the squares of any the like powers of the former series, as the squares, 0, 1, 4, 9, &c. or cubes, 0, 1, 8, 27: and then again take the sum of the series of powers to any number of terms, and also multiply the last of the terms summed by the number of terms, (reckoning always 0 for the first term,) the ratio of that sum, to that product, is more than $\frac{1}{n \times 1}$, (n being the index of the powers,) that is, in the series of squares it is more than $\frac{1}{3}$; in the cubes more than $\frac{1}{4}$; and so on: but the series going on in infinitum, we may take in more and more terms, without end, into the sum; and the more we take, the ratio of the sum to the product mentioned grows less and less; yet so as it never can actually be equal to $\frac{1}{n \times 1}$, but approaches infinitely near to it, or within less than any assignable difference.

"The nature, origin, &c. of series."—Infinite series commonly arise, either from a continued division, or the extraction of roots, as first performed by Sir I. Newton, who also explained other general ways for the expanding of quantities into infinite series, as by the binomial theorem. Thus, to divide 1 by 3, or to expand the fraction $\frac{1}{3}$ into an infinite series; by division in decimals in the ordinary way, the series is 0.3333, &c. or $\frac{3}{10} + \frac{3}{100} + \frac{3}{1000} + \frac{3}{10000}$, &c. where the law of continuation is manifest. Or, if the same fraction $\frac{1}{3}$ be set in this form $\frac{1}{2+1}$, and division be performed in the algebraic manner, the quotient will be $\frac{1}{3} = \frac{1}{2+1} = \frac{1}{2} - \frac{1}{4} + \frac{1}{8} - \frac{1}{16} + \frac{1}{32}$, &c. Or, if it be expressed in this form,

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$\frac{1}{3} = \frac{1}{4-1}$, by a like division there will arise the series,

$\frac{1}{3} = \frac{1}{4} + \frac{1}{16} + \frac{1}{64}$, &c. $= \frac{1}{4} + \frac{1}{4^2} + \frac{1}{4^3}$ &c. And thus, by dividing 1 by 5—2, or 6 — 3, or 7 — 4, &c. the series answering to the fraction $\frac{1}{3}$ may be found in an endless variety of infinite series; and the finite quantity $\frac{1}{3}$ is called the value or radix of the series, or also its sum, being the number or sum to which the series would amount, or the limit to which it would tend or approximate, by summing up its terms, or by collecting them together one after another. In like manner, by dividing 1 by the algebraic sum $a + c$, or by $a - c$, the quotient will be in these two cases as below, *viz.*

$$\frac{1}{a+c} = \frac{1}{a} - \frac{c}{a^2} + \frac{c^2}{a^3} - \frac{c^3}{a^4}, \text{ \&c.}$$

$$\frac{1}{a-c} = \frac{1}{a} + \frac{c}{a^2} + \frac{c^2}{a^3} + \frac{c^3}{a^4}, \text{ \&c.}$$

where the terms of each series are the same, and they differ only in this, that the signs are alternately positive and negative in the former, but all positive in the latter.

And hence, by expounding a and c by any numbers whatever, we obtain an endless variety of infinite series, whose sums or values are known. So by taking a or c equal to 1, or 2, or 3, or 4, &c. we obtain these series, and their values;

$$\frac{1}{1+1} - \frac{1}{2} = 1 - 1 + 1 - 1 + 1 - 1, \text{ \&c.}$$

$$\frac{1}{3-1} = \frac{1}{2} = \frac{1}{3} + \frac{1}{3^2} + \frac{1}{3^3} + \frac{1}{3^4}, \text{ \&c.}$$

$$\frac{1}{2+1} = \frac{1}{3} = \frac{1}{2} - \frac{1}{2^2} + \frac{1}{2^3} + \frac{1}{2^4}, \text{ \&c.}$$

$$\frac{1}{1-2} = \frac{1}{3} = 1 - 2 + 2^2 - 2^3, \text{ \&c.}$$

$$\frac{1}{3+1} = \frac{1}{4} = \frac{1}{3} - \frac{1}{3^2} + \frac{1}{3^3} + \frac{1}{3^4}, \text{ \&c.}$$

And hence it appears, that the same quantity or radix may be expressed by a great variety of infinite series, or that many different series may have the same radix, or sum.

Another way in which an infinite series arises, is by the extraction of roots. Thus, by extracting the square root of the number 3 in the common way, we obtain its value in a series as follows, *viz.* $\sqrt{3} = 1.73205$, &c. $= 1 + \frac{7}{10} + \frac{3}{100} + \frac{2}{1000} + \frac{5}{100000}$, &c. in which way of resolution the law of the progression of the series is not visible, as it is when found by division. And the square root of the algebraic quantity $a^2 + c^2$ gives

$$\sqrt{a^2 + c^2} = a + \frac{c^2}{2a} - \frac{c^4}{8a^3} + \frac{c^6}{16a^5}, \text{ \&c.}$$

And a third way is by Newton's binomial theorem, which is an universal method that serves for all sorts of quantities, whether fractional or radical ones: and by this means the same root of the last given quantity becomes $\sqrt{a^2 + c^2} = a + \frac{c^2}{2a} - \frac{1.c^4}{2.4a^3} + \frac{1.3\,c^6}{2.4.6\,a^5} + \frac{1.3.5c^8}{2.4.6.8a^7}$, &c. where the law of continuation is visible.

Hence it appears that the signs of the terms may be either all plus, or alternately plus and minus, though they may be varied in many other ways. It also appears that the terms may be either continually smaller and smaller, or larger and larger, or else all equal. In the first case, therefore, the series is said to be a *decreasing* one; in the second case, an *increasing* one; and in the third case, an *equal* one. Also the first series is called a *converging* one, because that, by collecting its terms successively, taking in always one term more, the successive sums approximate or converge to the value or sum of the whole infinite series. So in the series

$$\frac{1}{3-1} = \frac{1}{2} = \frac{1}{3} + \frac{1}{9} + \frac{1}{27} + \frac{1}{81}, \text{ \&c.}$$

the first term $\frac{1}{3}$ is too little or below $\frac{1}{2}$, which is the value or sum of the whole infinite series proposed; the sum of the first two terms $\frac{1}{3} + \frac{1}{9}$ is $\frac{4}{9} = .4444$, &c. is also too little, but nearer to $\frac{1}{2}$ or .5 than the former; and the sum of three terms $\frac{1}{3} + \frac{1}{9} + \frac{1}{27}$ is $\frac{13}{27} = .481481$, &c. is nearer than the last, but still too little; and the sum of four terms

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$\frac{1}{3}+\frac{1}{9}+\frac{1}{27}+\frac{1}{81}$ is $\frac{40}{81}$ = .493827, &c. which is again nearer than the former, but still too little; which is always the case when the terms are all positive.—But when the converging series has its terms alternately positive and negative, then the successive sums are alternately too great and too little, though still approaching nearer and nearer to the final sum or value. Thus, in the series

$\frac{1}{3+1}=\frac{1}{4}=0.25=\frac{1}{3}-\frac{1}{9}+\frac{1}{27}-\frac{1}{81}$, &c.

the 1st term $\frac{1}{3}$ = .333, &c. is too great;

two terms $\frac{1}{3}-\frac{1}{9}$ = .222, &c. are too little;

three terms $\frac{1}{3}-\frac{1}{9}+\frac{1}{27}$ = .259259, &c. are too great.

four terms $\frac{1}{3}-\frac{1}{9}+\frac{1}{27}-\frac{1}{81}$ = .246913, &c. are too great, and so on, alternately too great and too small, but every succeeding sum still nearer than the former, or converging.

In the second case, or when the terms grow larger and larger, the series is called a *diverging* one, because that, by collecting the terms continually, the successive sums diverge, or go always further and further from the true value or radix of the series; being all too great when the terms are all positive, but alternately too great and too little when they are alternately positive and negative. Thus, in the series

$\frac{1}{1+2}=\frac{1}{3}=1-2+4-8$, &c.

the first term $+1$ is too great;
two terms $1-2=-1$ are too little;
three terms $1-2+4=+3$ are too great;
four terms $1-2+4-8=-5$ are too little; and so on continually, after the 2d term, diverging more and more from the true value or radix $\frac{1}{3}$, but alternately too great and too little, or positive and negative. But the alternate sums would be always more and more too great if the terms were all positive, and always too little if negative.

But in the third case, or when the terms are all equal, the series of equals, with alternate signs, is called a *neutral* one because the successive sums, formed by a continual collection of the terms, are always at the same distance from the true value or radix, but alternately positive and negative, or too great and too little. Thus, in the series,

$\frac{1}{1+1}+\frac{1}{2}=1-1+1-1+1-1$, &c.

the first term is 1 is too great;
two terms $1-1=0$ are too little;
three terms $1-1+1=1$ too great;
four terms $1-1+1-1=0$ too little;
and so on, continually, the successive sums being alternately 1 and 0, which are equally different from the true value, or radix, $\frac{1}{2}$, the one as much above it as the other below it.

A series may be terminated and rendered finite, and accurately equal to the sum or value, by assuming the supplement, after any particular term, and combining it with the foregoing terms. So, in the series $\frac{1}{2}-\frac{1}{4}+\frac{1}{8}-\frac{1}{16}$, &c. which is equal to $\frac{1}{3}$, and found by dividing 1 by $2+1$, after the first term, $\frac{1}{2}$, of the quotient, the remainder is $-\frac{1}{2}$, which, divided by $2+1$, or 3, gives $-\frac{1}{6}$ for the supplement, which combined with the first term, $\frac{1}{2}$, gives $\frac{1}{2}-\frac{1}{6}=\frac{1}{3}$, the true sum of the series. Again, after the first two terms $\frac{1}{2}-\frac{1}{4}$, the remainder is $+\frac{1}{4}$, which, divided by the same divisor, 3, gives $\frac{1}{12}$ for the supplement, and this combined with those two terms $\frac{1}{2}-\frac{1}{4}$, makes $\frac{1}{2}-\frac{1}{4}+\frac{1}{12}=\frac{1}{4}+\frac{1}{12}=\frac{4}{12}$ or $\frac{1}{3}$ the same sum or value as before. And, in general, by dividing 1 by $a+c$, there is obtained

$\frac{1}{a+c}=\frac{1}{a}-\frac{c}{a^2}+\frac{c^2}{a^3}\ldots\pm\frac{c^n}{a^{n+1}}\mp\frac{c^{n+1}}{a^{n+1}(a+c)}$; where stopping the division at any term, as $\frac{c^n}{a^{n+1}}$, the remain-

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der after this term is $\frac{c^{n+1}}{a^{n+1}}$, which, being divided by the same divisor, $a+c$, gives $\frac{c^{n+1}}{a^{n+1}(a+c)}$ for the supplement as above.

"The Law of Continuation."—A series being proposed, one of the chief questions concerning it is to find the law of its continuation. Indeed no universal rule can be given for this; but it often happens, that the terms of the series, taken two and two, or three and three, or in greater numbers, have an obvious and simple relation, by which the series may be determined and produced indefinitely. Thus, if 1 be divided by $1-x$, the quotient will be a geometrical progression, *viz.* $1+x+x^2+x^3$, &c. where the succeeding terms are produced by the continual multiplication by x. In like manner, in other cases of division, other progressions are produced.

But, in most cases, the relation of the terms of a series is not constant, as it is in those that arise by division. Yet their relation often varies according to a certain law, which is sometimes obvious on inspection, and sometimes it is found by dividing the successive terms one by another, &c. Thus, in the series

$$1+\frac{2}{3}x+\frac{8}{15}x^2+\frac{16}{35}x^3+\frac{128}{315}x^4,$$

&c by dividing the 2d term by the 1st, the 3d by the 2d, the 4th by the 3d, and so on, the quotients will be

$$\frac{2}{3}x, \frac{4}{5}x, \frac{6}{7}x, \frac{8}{9}x, \text{\&c.};$$

and, therefore, the terms may be continued indefinitely, by the successive multiplication by these fractions. Also in the following series

$$1+\frac{1}{6}x+\frac{3}{40}x^2+\frac{5}{128}x^3+\frac{35}{1152}x^4,$$

&c. by dividing the adjacent terms successively by each other, the series of quotients is

$$\frac{1}{6}x, \frac{9}{20}x, \frac{25}{42}x, \frac{49}{72}x, \text{\&c.; or}$$

$$\frac{1.1}{2.3}x, \frac{3.3}{4.5}x, \frac{5.5}{6.7}x, \frac{7.7}{8.9}x, \text{\&c.}$$

and, therefore, the terms of the series may be continued by the multiplication of these fractions.

SERIES, *summation of.* We have before seen the method of determining the sums of quantities in arithmetical and geometrical progression, but when the terms increase or decrease, according to other laws, different artifices must be used to obtain general expressions for their sum.

The methods chiefly adopted, and which may be considered as belonging to algebra, are, 1. The method of subtraction. 2. The summation of recurring series by the scale of relation. 3. The differential method. 4. The method of increments. We shall content ourselves with an example or two in the first of these methods.

"The investigation of series, whose sums are known by subtraction."

Ex. 1. Let $1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+$, &c. in inf. $=S$, then

$\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+$, &c. in inf. $=S-1$

by subtraction, $\frac{1}{1.2}+\frac{1}{2.3}+\frac{1}{3.4}+$, &c. in inf. $=1$; or $\frac{1}{2}+\frac{1}{6}+\frac{1}{12}+\frac{1}{20}$, &c. $=1$.

Ex. 2. Let $1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+$, &c. in inf. $=S$. Then

$\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}+$, &c. in inf. $=S-\frac{3}{2}$,

by subtraction, $\frac{2}{1.3}+\frac{2}{2.4}+\frac{2}{3.5}+\frac{2}{4.6}+$, &c. in inf. $=\frac{3}{2}$;

or $\frac{1}{1.3}+\frac{1}{2.4}+\frac{1}{3.5}+\frac{1}{4.6}+$, &c. in inf. $=\frac{3}{4}$.

Ex. 3. Let $\frac{1}{1.2}+\frac{1}{2.3}+\frac{1}{3.4}+$, &c. in inf. $=S$,

then $\frac{1}{2.3}+\frac{1}{3.4}+\frac{1}{4.5}+$, &c. in inf. $=S-\frac{1}{2}$,

by subtraction, $\frac{2}{1.2.3}+\frac{2}{2.3.4}+\frac{2}{3.4.5}+$, &c. in inf. $=\frac{1}{2}$,

and $\frac{1}{1.2.3}+\frac{1}{2.3.4}+\frac{1}{3.4.5}+$, &c. in inf. $=\frac{1}{4}$.

Ex. 4. Let $\frac{1}{m}+\frac{1}{m+r}+\frac{1}{m+2r}+\ldots\ldots\frac{1}{m+\overline{n-1}.r}+\frac{1}{m+nr}=S$,

then $\frac{1}{m+r}+\frac{1}{m+2r}+\frac{1}{m+3r}+\ldots$

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$\frac{1}{m+nr} = S - \frac{1}{m}$,

by subtraction, $\frac{r}{m.m+r} + \frac{r}{m+r.m+2r}$ + &c. (to n terms) $+ \frac{1}{m+nr} = \frac{1}{m}$;

hence, $\frac{r}{m.m+r} + \frac{r}{m+r.m+2r}$ +, &c. (to n terms) $= \frac{1}{m} - \frac{1}{m+nr}$,

and $\frac{1}{m.m+r} + \frac{1}{m+r.m+2r}$ +, &c. (to n terms) $= \frac{1}{mr} - \frac{1}{mr+nr^2}$.

If n be increased without limit, $\frac{1}{mr+nr^2}$ vanishes, and the sum of the series is $\frac{1}{mr}$.

If $m = r = 1$, we have $\frac{1}{1.2} + \frac{1}{2.3} + \frac{1}{3.4}$ +, &c. (to n terms) $= 1 - \frac{1}{1+n} = \frac{n}{1+n}$.

Similar to the method of subtraction is the following, given by De Moivre.

"Assume a series, whose terms converge to o, involving the powers of an indeterminate quantity, x; call the sum of the series S, and multiply both sides of the equation by a binomial, trinomial, &c. which involves the powers of x, and invariable co-efficients; then, if x be so assumed, that the binomial, trinomial, &c. may vanish, and some of the first terms be transposed, the sum of the remaining series is equal to the terms so transposed."

Let $1 + \frac{x}{2} + \frac{x^2}{3} + \frac{x^3}{4}$ +, &c. in inf $= S$.

Multiplying both sides by $x-1$, we have

$$\left.\begin{array}{l} x + \frac{x^2}{2} + \frac{x^3}{3} + \frac{x^4}{4} +, \text{ \&c.} \\ -1 - \frac{x}{2} - \frac{x^2}{3} - \frac{x^3}{4} - \frac{x^4}{5} -, \text{\&c.} \end{array}\right\} = \overline{x-1}\, S.$$

or $-1 + \frac{x}{1.2} + \frac{x^2}{2.3} + \frac{x^3}{3.4}$ +, &c $= \overline{x-1}\, S$; and if $x = 1$,

then, $-1 + \frac{1}{1.2} + \frac{1}{2.3} + \frac{1}{3.4}$ +, &c. $= 0$;

or, $\frac{1}{1.2} + \frac{1}{2.3} - \frac{1}{3.4}$ +, &c. in inf. $= 1$.

SERIOLA, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx simple; pappus subplumose; receptacle chaffy. There are four species.

SERIPHIUM, in botany, a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Compositæ Nucamentaceæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate; corolla one-petalled, regular: seed one, oblong, below the corolla. There are four species, all natives of the Cape of Good Hope.

SERPENTINE, in mineralogy, a species of the Talc genus, divided by Werner into the common and precious: the common is chiefly green, though passing into various other colours, which are seldom uniform. There are generally several colours together, and these are arranged in striped, dotted, and clouded delineations. It occurs massive; internally it is faintly glimmering, which passes into dull, when there are no foreign particles to give a slight degree of lustre. It is soft, not very brittle, and frangible. Feels a little greasy, not very heavy. It is infusible before the blow-pipe without addition. It consists of

Magnesia	23
Silica	45
Alumina	18
Iron	3
Water	12
	101

It is one of the primitive rocks; is found in many parts of Germany, Italy, Siberia, in this country, Scotland, and the Shetland islands. It takes a good polish, and is turned into vessels and ornaments of a great variety of shapes. In Upper Saxony, several hundred people are employed in quarrying, cutting, turning, and polishing the serpentine, which occurs in that neighbourhood, and the articles into which it is manufactured are carried all over Germany. The precious is found in Silesia.

SERPICULA, in botany, a genus of the Monoecia Tetrandria class and order. Natural order of Inundatæ. Onagræ. Jussieu. Essential character: male, calyx four-toothed; corolla four-petalled; female, calyx four-parted; pericarpium nut tumentose. There are two species, *viz.* S verticillata and S. repens.

SERPULA, in natural history, a genus of the Vermes Testacea class and order: animal a terebella: shell univalve, gene-

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rally adhering to other substances: often separated internally by divisions at uncertain distances. About fifty species have been enumerated.

SERPENTES, in natural history, an order of the Amphibia, containing seven genera, *viz.*

Achrochordus	Cœcilia
Amphisbæna	Coluber
Anguis	Crotalus
Boa	

Serpents are distinguished as footless amphibia: their eggs are connected in a chain: penis frequently double: they breathe through the mouth. The amphibia were divided by Linnæus into four orders; *viz.* Reptilia, Serpentes, Meantes, and Nantes. Of the Meantes or gliders, which were characterized as breathing by means of gills and lungs together, feet branchiated, and furnished with claws, there was but a single genus, *viz.* the siren: this has since been classed with the reptiles. See REPTILIA and SIREN.

The nantes, or swimming amphibia, characterized by their having fins, and by breathing by means of lateral gills, were afterwards distributed into the orders of fishes denominated branchiostigi, and chondropterygii, which have since been ranked by Dr. Shaw, and others, under the general term cartilaginous fishes. See CHRONDROPTERIGIOUS.

We have thought it right to give this account of the changes in the Linnæan system, which we have generally adopted, having omitted any mention of the facts under the former articles. "Serpents," says the translator of Gmelin, "are cast naked upon the earth, without limbs, exposed to every injury, but frequently armed with a poison the most deadly and horrible: this is contained in tubular fangs resembling teeth, placed without the upper jaw, protruded or retracted at pleasure, and surrounded with a glandular vesicle, by which this fatal fluid is secreted: but lest this tribe should too much encroach upon the limits of other animals, the benevolent Author of nature has armed about a fifth part only in this dreadful manner, and has ordained that all should cast their skins, in order to inspire a necessary suspicion of the whole. The jaws are dilatable, and not articulate, and the œsophagus so lax, that they can swallow without any mastication, an animal twice as thrice as large as the neck: the colour is variable, and changes, according to the season, age, or mode of living, and frequently vanishes, or turns to another in the dead body: tongue filiform, bifid; skin reticulate." The distinction between the poisonous and innoxious serpents is only to be known by an accurate examination of their teeth; those which are poisonous being always tubular, and calculated for the injection of the poisonous fluid, from a peculiar reservoir communicating with the fang on each side of the head. These teeth or fangs are situated in the upper jaw: they are frequently accompanied by smaller fangs, seemingly intended to supply the place of the others, if lost by age or accident. The fangs are situated in a peculiar bone, so articulated with the rest of the jaw as to elevate or depress them at the pleasure of the animal: in a quiescent state, they are recumbent, with their points directed inwards or backwards; but when the animal is inclined to use them as weapons of offence, their position is altered by the peculiar mechanism of the bone in which they are rooted, and they become almost perpendicular.

Serpents in cold and temperate climates conceal themselves, during winter, in cavities, beneath the surface of the ground, or in any other convenient places of retirement, where they become nearly or wholly in a state of torpidity. Some serpents are viviparous, as the rattlesnake, the viper, &c.: while the innoxious species are oviparous, depositing, as we have observed, their eggs in a kind of chain in any warm and close situation, where they are afterwards hatched. The broad undivided laminæ on the bellies of serpents are termed scuta, and the smaller or divided ones beneath the tail are called subcaudal scales, and from these different kinds of laminæ the Linnæan genera are characterized,

SERRATULA, in botany, *saw-wort*, a genus of the Syngenesia Polygamia Æquilis class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx, subcylindrical, imbricate, awnless. There are twenty species.

SERROPALPUS, in natural history, a genus of insects of the order Coleoptera: antennæ setaceous; four feelers, unequal; the anterior ones longer, deeply serrate, composed of four joints, the last joint very large, truncate, compressed, patelli-

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form; the posterior one subclavate; thorax margined, concealing the head, with a prominent angle on each side; head deflected; feet formed for digging. There are two species, *viz.* S. striatus, which is of a brown colour, with striated shells, found in autumn in old buildings: S. lævigatus, which is black and smooth.

SERTULARIA, in natural history, a genus of the Vermes Zoophyta class and order: animal growing in the form of a plant; stem branched, producing polypes, from cup-shaped denticles or minute cells. Nearly fourscore species have been enumerated. These are divided into two classes: A. stem horny, tubular, fixed by the base, beset with cup-shaped denticles, and furnished with vesicles or ovaries, containing polypes, eggs, or the living young. B. stem crustaceous, inclining to stone, and composed of rows of cells: there are no vesicles, but in the place of them are small globules.

SERUM. See Blood.

SESAMUM, in botany, *sesamum*, or *oily-grain*, a genus of the Didynamia Angiospermia class and order. Natural order of Luridæ. Bignoniæ, Jussieu Essential character: calyx five-parted: corolla bell-shaped, five-cleft, the lower lobe larger; rudiment of a fifth filament; stigma lanceolate; capsule four-celled. There are three species, *viz* the orientale, the indicum, and the luteum. S. orientale has ovate, oblong, entire leaves. It is an annual, and grows naturally on the coast of Malabar and in the island of Ceylon; rising with an herbaceous four-cornered stalk, two feet high, sending out a few short side branches. After the flowers are past, the germen turns to an oval-acute pointed capsule, with four cells, filled with oval compressed seeds, which ripen in autumn. S. indicum, with trifid lower leaves, grows naturally in India; this is also an annual plant; the stalk rises taller than that of the former; the lower leaves are cut into three parts, which is the only difference between them. The first sort is frequently cultivated in all the eastern countries, and also in Africa, as a pulse; and of late years the seeds have been introduced into Carolina by the African negroes, where they succeed extremely well. The inhabitants of that country make an oil from the seed, which will keep good for many years, without having any rancid smell or taste, but in two years becomes quite mild; so that when the warm taste of the seed, which is in the oil when first drawn, is worn off, they use it as a salad-oil, and for all the purposes of sweet oil. The seeds of this plant are also used by the negroes for food; which seeds they parch over the fire, and then mix them with water, and stew other ingredients with them, which makes a hearty food.

SESELI, in botany, *meadow saxifrage*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ or Umbelliferæ. Essential character: umbels globular; involucre of one or two leaflets; fruit ovate, striated. There are fifteen species.

SESSIONS *of the peace*. See Quarter *Sessions*.

SESUVIUM, in botany, a genus of the Icosandria Trigynia class and order. Natural order of Succulentæ. Ficoideæ, Jussieu. Essential character: calyx five-parted, coloured: petals none: capsule ovate, three-celled, cut round, many-seeded. There is only one species, *viz.* S portulacastrum, a native of the West Indies.

SET *off*, in law, is when the defendant acknowledges the justice of the plaintiff's demand on the one hand, but on the other sets up a demand of his own, to counterbalance that of the plaintiff, either in the whole or in part; as if the plaintiff sue for 10*l.* due on a note of hand, the defendant may set off 9*l.* due to himself for merchandize sold to the plaintiff, or for any other demand, the amount of which is ascertained in damages.

The action in which a set off is allowable upon the statutes 2 and 3 George II. c. 22 and 24, are debt, covenant, and assumpsit, for the non-payment of money; and the demand intended to be set off must be such as might have been made the subject of one or other of these actions. A set off, therefore, is never allowed in actions upon the case, trespass, replevin, &c.; nor of a penalty in debt on bond conditioned for the performance of covenants, &c.; nor of general damages in covenant or assumpsit: but where a bond is conditioned for the payment of an annuity, a set off may be allowed. A debt barred by the statute of limitations cannot be set off; and if it be pleaded in bar to the action, the plaintiff may reply the statute of limitations; or if given in evidence, on a notice of set off, which is one mode of setting up this sort of counter demand, it may be objected to at the trial.

SET, or Sets, a term used by the farmers and gardeners to express the young plants of the white thorn and other shrubs, with which they used to raise their quick or quickset hedges.

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SETON, in surgery, a few horse hairs, small threads, or large packthread, drawn through the skin, chiefly the neck, by means of a large needle or probe, with a view to restore, or preserve health.

SETTE, a vessel very common in the Mediterranean, with one deck and a very long and sharp prow: they carry, some two masts, some three, without top-masts. Their yards and sails are all like the mizen: the least of them are of sixty tons burden. They serve to transport cannon and provisions for ships of war, and the like.

SETTING, in astronomy, the withdrawing of a star or planet, or its sinking below the horizon. Astronomers and poets make three different kinds of setting of the stars, *viz.* the cosmical, achronical, and heliacal.

Setting, in the sea language. To set the land or the sun, by the compass, is to observe how the land bears on any point of the compass, or on what point of the compass the sun is. Also, when two ships sail in sight of one another, to mark on what point the chased bears, is termed setting the chase by the compass.

SEWER, in the household, an officer who comes in before the meat of a king or nobleman, to place and range it on the table.

Sewer is also a passage or gutter made to carry water into the sea or a river, whereby to preserve the land, &c. from inundations and other annoyances. The business of the commissioners of sewers, or their office in particular, is to repair seabanks and walls, survey rivers, public streams, ditches, &c. and to make orders for that purpose These commissioners have likewise authority to make inquiry of all nuisances or offences committed by the stopping of rivers, erecting mills, not repairing banks, bridges, &c. and to tax persons chargeable for the amending of defaults that tend to the obstruction or hindrance of the free passage of the water through its ancient courses. They may not only make a rate and assessment for repairs, but also may decree lands to be sold, in order to levy charges assessed upon non-payment thereof, &c. But the decrees of the commissioners are to be certified in Chancery, and have the King's assent, to be binding, and their proceedings are subject to the jurisdiction of the King's Bench. In the making of a rate or tax, the commissioners are to assess every owner, or possessor of lands, in danger of receiving any damage by the waters, equally, according to the quality of their lands, rents, and numbers of acres, and their respective portions and profits, whether it be of pasture, fishing, &c And where no persons or lands can be known that are liable to make repairs of banks and sewers, then the commissioners are to rate the whole level. The 3 James I ordains that all ditches, banks, bridges, and water-houses, within two miles of London, adjoining to and falling into the Thames, shall be subject to the commissioners of sewers. Also the Lord Mayor, &c. may appoint persons in that case to have the power of commissioners of sewers. Persons breaking down sea banks, whereby lands are damaged, are adjudged to be guilty of felony; and removing piles, &c. forfeit 20*l.* by 6 and 10 George II. c. 32.

SEX, something in the body which distinguishes male from female.

SEXAGENARY, something relating to the number sixty. Thus sexagenary, or sexagesimal arithmetic, is a method of computation proceeding by sixties: such is that used in the division of a degree into sixty minutes, of the minute into sixty seconds, of the second into sixty thirds, &c Also sexagenary tables are tables of proportional parts, showing the product of two sexagenaries that are to be multiplied, or the quotient of the two that are to be divided.

SEXAGESIMALS, or Sexagesimal *fractions;* fractions whose denominators proceed in a sexagecuple ratio; that is, a prime, or the first minute $= \frac{1}{60}$; a second $= \frac{1}{3600}$ a third $= \frac{1}{216000}$.

Anciently there were no other than sexagesimals used in astronomy, and they are still retained in many cases, though decimal arithmetic has now grown into use in astronomical calculations. In these fractions, which some call astronomical fractions, the denominator being always sixty, or a multiple thereof, is usually omitted, and the numerator only written down, thus, $4^\circ, 59', 32'', 50''', 16''''$, is to be read, four degrees, fifty-nine minutes, thirty-two seconds, fifty thirds, sixteen fourths, &c.

SEXANGLE, in geometry, a figure having six sides, and consequently six angles.

SEXTANS, a sixth part of certain things. The Romans having divided their *as* into twelve ounces, or *uncia*, the sixth part of that, or two ounces, was the sextans. Sextans was also a measure which contained two ounces of liquor, or two cyathi.

SEXTANT, in mathematics, denotes the sixth part of a circle, or an arch comprehending sixty degrees. The word sextant is more particularly used for an as-

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tronomical instrument made like a quadrant, excepting that its limb only comprehends sixty degrees. The use and application of the sextant is the same with that of the quadrant. See QUADRANT.

SEXTILE, the position or aspect of two planets when at sixty degrees distance, or at the distance of two signs from one another. It is marked thus (*).

SEXTON, a church officer, whose business is to take care of the vessels, vestments, &c. belonging to the church, and to attend the minister, churchwardens, &c. at church. He is usually chosen by the parson only. The office of sexton, in the Pope's chapel is appropriated to the order of the hermits of St. Augustine He is generally a bishop, though sometimes the Pope only gives a bishoprick in particular to him on whom he confers the post: he takes the title of prefect of the Pope's sacristy, and has the keeping of the vessels of gold and silver, the relics, &c. When the Pope says mass, the sexton always tastes the bread and wine first. If it be in private, he says mass, his Holiness of two wafers gives him one to eat; and if in public, the cardinal, who assists the Pope in quality of deacon, of three wafers gives him one to eat. When the Pope is very sick, he administers to him the sacrament of extreme unction, &c. and enters the conclave in quality of first conclavist.

SEXUAL *system*, in botany, that system of classification which was invented by the immortal Linnæus, professor of physic and botany, at Upsal, in Sweden. It is founded on the parts of fructification, *viz.* the stamens and pistils; these having been observed with more accuracy since the discovery of the uses for which nature has assigned them, a new set of principles have been derived from them, by means of which the distribution of plants has been brought to a greater precision, and rendered more conformable to true philosophy in this system, than in any one of those which preceded it. The author does not pretend to call it a natural system; he gives it as artificial only, and modestly owns his inability to detect the order pursued by nature in her vegetable productions; but of this he seems confident, that no natural order can ever be framed, without taking in the materials out of which he has raised his own; and urges the necessity of admitting artificial systems for convenience, till one truly natural shall appear. Linnæus has given us his "Fragmenti Methodi Naturalis," in which he has made a distribution of plants under various orders, putting together in each such as appear to have a natural affinity to each other: this, after a long and fruitless search after the natural method, he gives as the result of his own speculation, for the assistance of such as may engage in the same pursuit hereafter. Not finding it practicable to form a system after the natural method, Linnæus was more fully convinced of the absolute necessity of adopting an artificial one, of which a detailed account is given under the article BOTANY.

SHAD, in ichthyology, a species of Clupea, with the upper jaw bifid at the extremity, and spotted with black; it greatly resembles the common herring, and is, on that account, sometimes called the mother of herring; all the fins are whitish, except that on the back; the tail is very much forked.

SHADOW, in optics, a privation or diminution of light by the interposition of an opaque body; or it is a plane, where the light is either altogether obstructed, or greatly weakened, by the interposition of some opaque body between it and the luminary. A shadow of itself is invisible; and therefore, when we say we see a shadow, we partly mean that we see bodies placed in the shadow, and illuminated by light reflected from collateral bodies; and, partly, that we see the confines of the light. If the opaque body that projects the shadow be perpendicular to the horizon, and the place it is projected on be horizontal, the shadow is called a right shadow; and such are the shadows of men, trees, buildings, mountains, &c. But if the opaque body be placed parallel to the horizon, the shadow is called a versed shadow; as the arms of a man stretched out, &c

"The laws of the projection of shadows from opaque bodies." 1. Every opaque body projects a shadow in the same direction with its rays; that is, towards the part opposite to the light. Hence, as either the luminary or the body changes place, the shadow likewise changes. 2 Every opaque body projects as many shadows as there are luminaries to enlighten it. 3. As the light of the luminary is more intense, the shadow is the deeper: hence the intensity of the shadow is measured by the degrees of light that space is deprived of. 4. If a luminous sphere be equal to an opaque one it illuminates, the shadow which this latter projects will be a cylinder, and consequently will be propagated still equal to itself, to whatever distance the luminary is capable of acting; so that if it be cut in

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any place, the plane of the section will be a circle, equal to a great circle of the opaque sphere. 5 If the luminous sphere be greater than the opaque one, the shadow will be conical. If, therefore, the shadow be cut by a plane, parallel to the base, the plane of section will be a circle; and that so much the less as it is a greater distance from the base. 6. If the luminous sphere be less than an opaque one, the shadow will be a truncated cone; and, consequently, grows still wider and wider; and, therefore, if cut by a plane parallel to the section, that plane will be a circle, so much the greater as it is further from the base.

The sun, being vastly larger than the whole globe of the earth, must give all its shadows pointed, by reason that it illumines more than half of them. In consequence of this demonstration we might conclude, that all the sun's shadows must be less than the bodies that project them, and diminished more and more as they recede further and further. Now this would be true, were there any relation between the body illuminated and the body illumining; but as all objects on the earth are so small in comparison of that star, the diminution of their shadows is imperceptible to the eye, which sees them always equal; *i. e.* either broader or narrower than the body that forms them: on this account, all the shadows caused by the sun are made in parallels. From the whole it appears that, to find the shadow of any body whatever opposed to the sun, a line must be drawn from the top of the luminary perpendicular to the place where the foot of the luminary is to be taken: and through this place an occult line is to be drawn through one of the angles of the plane of the object, and another from the sun to the same angle; and the intersection of the two lines will show how far the shadow is to go: all the other lines must be drawn parallel hereto. The shadows of the sun are equal in objects of the same height, though at a distance from each other. Experience teaches, that stiles, or elevations of the same height, removed to a distance from each other, do yet project equal shadows at the same time: for they are lengthening and shortening in proportion as the sun comes nearer, or recedes further off; one or other of which he is continually doing.

Shadow, in geography. The inhabitants of the terraqueous globe of the earth receive different denominations, according to the different ways wherein their shadows are projected; as ascii, amphiscii, heteroscii, and periscii.

Shadow, in painting, an imitation of a real shadow, effected by gradually heightening and darkening the colours of such figures, as by their dispositions cannot receive any direct rays from the luminary that is supposed to enlighten the piece. The management of the shadows and lights makes what the painters call claro-obscuro.

SHAFT *of a column*, in building, is the body thereof between the base and capital: so called from its straightness. The term shaft is also used for the spire of a church steeple, and for the tunnel of a chimney. See Architecture.

Shaft, in mining, is the pit or hollow entrance into the mine.

SHAGREEN, or Chagreen, in commerce, a kind of grained leather, prepared, as is supposed, of the skin of a species of squalus, or hound-fish, called the shagree or shagrain, and much used in covering cases, books, &c. It is imported from Constantinople, Tauris, Tripoli, Algiers, and from some parts of Poland, where it is prepared in the following manner: the skin being stretched out, is first covered over with mustard seed, which is bruised upon it; and being thus exposed to the weather for some days, it is then tanned. The best is of a brownish colour, as the white sort is the worst; it is extremely hard; yet, when steeped in water, it becomes soft and pliable; and being fashioned into case-covers, it readily takes any colour, as red, green, yellow, black, according to the fancy of the workmen

SHAMBLES, among miners, a sort of niches or landing places, left at such distances in the adits of mines, that the shovelmen may conveniently throw up the ore from shamble to shamble, till it comes to the top of the mine.

SHAMMY, or Chamois *Leather*, a kind of leather, dressed either in oil or tanned; and much esteemed for its softness, pliancy, and being capable of bearing soap without hurt. The true shammy is prepared of the skin of the chamois-goat. See Capra.

The true chamois leather is counterfeited with common goat, kid, and even sheep-skin: the practice of which makes a particular profession, called by the French chamoisure. The last is the least esteemed, yet so popular, and such vast quantities prepared, especially about Orleans, Marseilles, and Thoulouse, that it

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may not be amiss to give the method of preparation.

"The manner of chamoising, or of preparing sheep, goat, or kid-skins, in oil, in imitation of chamois." The skins being washed, drained, and smeared over with quick lime, on the fleshy side, are folded in two, lengthwise, the wool outwards, and laid on heaps, and so left to ferment eight days; or, if they had been left to dry after flaying, for fifteen days. Then they are washed out, drained, and half-dried, laid on a wooden leg or horse, the wool stripped off with a round staff for the purpose, and laid in a weak pit, the lime whereof had been used before, and had lost the greatest part of its force. After twenty-four hours they are taken out, and left to drain twenty-four more; then put in another strong pit. This done, they are taken out, drained, and put in again by turns; which begins to dispose them to take oil: and this practice they continue for six weeks in summer, or three months in winter: at the end whereof they are washed out, laid on the wooden leg, and the surface of the skin on the wool side peeled off, to render them the softer; then made into parcels, steeped a night in the river; in winter, more; stretched six or seven over one another on the wooden leg; and the knife passed strongly on the flesh side, to take off any thing superfluous, and render the skin smooth. Then they are stretched as before in the river, and the same operation repeated on the wool side; then thrown into a tub of water with bran in it, which is brewed among the skins till the greatest part sticks to them; and then separated into distinct tubs, till they swell and rise of themselves above the water. By this means the remains of the lime are cleared out: they are then wrung out, hung up to dry on ropes, and sent to the mill, with the quantity of oil necessary to scour them: the best oil is that of stock-fish. Here they are first thrown in bundles into the river for twelve hours, then laid in the mill trough, and fulled without oil till they be well softened; then oiled with the hand, one by one, and thus formed into parcels of four skins each, which are milled and dried on cords a second time, then a third; then oiled again and dried.

This process is repeated as often as necessity requires; when done, if there be any moisture remaining, they are dried in a stove, and made up into parcels wrapped up in wool; after some time they are opened to the air, but wrapped up again as before, till such time as the oil seems to have lost all its force, which it ordinarily does in twenty-four hours.

The skins are then returned from the mill to the chamoiser to be scoured; which is done by putting them into a lixivium of wood-ashes, working and beating them in it with poles, and leaving them to steep till the ley has had its effect; then wrung out, steeped in another lixivium, wrung again, and this repeated till all the grease and oil be purged out. They are then half dried, and passed over a sharp-edged iron instrument, placed perpendicular in a block, which opens, softens, and makes them pliable; lastly, they are thoroughly dried, and passed over the same instrument again, which finishes the preparation, and leaves them in the form of shammy.

Kid and goat skins are chamoised in the same manner as those of sheep, excepting that the hair is taken off without the use of any lime; and that when brought from the mill they undergo a particular preparation called ramalling, the most delicate and difficult of all the others. It consists in this, that as soon as brought from the mill they are steeped in a fit lixivium, taken out, stretched on a round wooden leg, and the hair scraped off with the knife; this makes them smooth, and, in working, cast a fine nap. The difficulty is in scraping them evenly.

SHARK, in ichthyology, the English name of two species of squalus, distinguished by their different colours, blue and white. See SQUALUS.

SHARP, (ABRAHAM,) in biography, an eminent mathematician, mechanist, and astronomer, was descended from an ancient family at Little Horton, near Bradford, in the west riding of Yorkshire, where he was born about the year 1651. At a proper age he was put apprentice to a merchant at Manchester; but his genius led him so strongly to the study of mathematics, both theoretical and practical, that he soon became uneasy in that situation of life. By the mutual consent, therefore, of his master and himself, though not altogether with that of his father, he quitted the business of a merchant. Upon this he removed to Liverpool, where he gave himself up wholly to the study of mathematics, astronomy, &c and where for a subsistence, he opened a school, and taught writing and accounts, &c.

He had not been long at Liverpool, when he accidentally feel in company with a merchant, or tradesman, visiting that town

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from London, in whose house it seems the astronomer Flamsteed then lodged. With the view, therefore, of becoming acquainted with this eminent man, Mr. Sharp engaged himself with the merchant as a book-keeper. In consequence he soon contracted an intimate acquaintance and friendship with Mr. Flamsteed, by whose interest and recommendation he obtained a more profitable employment in the dock-yard at Chatham, where he continued till his friend and patron, knowing his great merit in astronomy and mechanics, called him to his assistance, in contriving, adapting, and fitting up the astronomical apparatus in the royal observatory at Greenwich, which had been lately built, namely, about the year 1676, Mr. Flamsteed being then thirty years of age, and Mr Sharp twenty-five.

In this situation he continued to assist Mr. Flamsteed in making observations (with the mural arch, of eighty inches radius, and 140 degrees on the limb, contrived and graduated by Mr. Sharp) on the meridional zenith distances of the fixed stars, Sun, Moon, and planets, with the time of their transit over the meridian; also the diameter of the Sun and Moon, and their eclipses, with those of Jupiter's satellites, the variation of the compass, &c. He assisted him also in making a catalogue of nearly 3000 fixed stars. as to their longitudes and magnitudes, their right ascensions and polar distances, with the variations of the same while they change their longitude by one degree.

But from the fatigue of continually observing the stars, at night, in a cold thin air, joined to a weakly constitution, he was reduced to a bad state of health; for the recovery of which he desired leave to retire to his house at Horton; where, as soon as he found himself on the recovery, he began to fit up an observatory of his own, having first made an elegant and curious engine for turning all kinds of work in wood or brass, with a maundril for turning irregular figures, as ovals, crosses, wreathed pillars, &c. Beside these, he made himself most of the tools used by joiners, clock-makers, opticians, mathematical instrument-makers, &c. The limbs or arcs of his large equatorial instrument, sextant, quadrant, &c. he graduated with the nicest accuracy, by diagonal divisions into degrees and minutes. The telescopes he made use of were all of his own making, and the lenses ground, figured, and adjusted with his own hands.

It was at this time that he assisted Mr. Flamsteed, in calculating most of the tables in the second volume of his "Historia Cœlestis," as appears by their letters, to be seen in the hands of Mr. Sharp's friends at Horton. Likewise the curious drawings of the charts of all the constellations visible in our hemisphere, with the still more excellent drawings of the planispheres, both of the northern and southern constellations. And though these drawings of the constellations were sent to be engraved at Amsterdam by a masterly hand, yet the originals far exceeded the engravings in point of beauty and elegance; these were published by Mr. Flamsteed, and both copies may be seen at Horton.

The mathematician meets with something extraordinary in Sharp's elaborate "Treatise of Geometry Improved," (in 4to. 1717, signed A. S. Philomath,) 1st. by a large and accurate table of segments of circles, its construction, and various uses in the solution of several difficult problems, with compendious tables for finding a true proportional part, and their use in these or any other tables exemplified in making logarithms, or their natural numbers, to 60 places of figures, there being a table of them for all primes to 1100, true to 61 figures. 2d. His consise "Treatise of Polyedra," or solid bodies of many bases, both the regular ones and other; to which are added twelve new ones, with various methods of forming them, and their exact dimensions in surds or species, and in numbers; illustrated with a variety of copper-plates, neatly engraved by his own hands. Also, the models of these polyedra he cut out in box-wood, with amazing neatness and accuracy. Indeed few or none of the mathematical instrument-makers could exceed him in exactly graduating or neatly engraving any mathematical or astronomical instrument, as may be seen in the equatorial instrument above mentioned, or in his sextant, quadrants, and dials of various sorts; also in a curious armillary sphere, which, beside the common properties, has moveable circles, &c. for exhibiting and resolving all spherical triangles; also his double sector, with many other instruments, all contrived, graduated, and finished by himself. In short, he possessed at once a remarkably clear head for contriving, and an extraordinary hand for executing any thing, not only in mechanics, but likewise in drawing, writing, and making the most exact and beautiful schemes or figures, in all his calculations and geometrical constructions.

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The quadrature of the circle was undertaken by him for his own private amusement in the year 1699, deduced from two different series, by which the truth of it was proved to 72 places of figures; as may be seen in the introduction to Sherwin's table of logarithms; that is, if the diameter of the circle be 1, the circumference will be found equal to 3 14 159265358979323846264338 3 795028841 971693993751058 20 749445923078164 5, &c. In the same book of Sherwin's may also be seen his ingenious improvements on the making of logarithms, and the constructing of the natural sines, tangents, and secants.

He also calculated the natural and logarithmic sines, tangents, and secants, to every second in the first minute of the quadrant; the laborious investigation of which may probably be seen in the archives of the Royal Society, as they were presented to Mr Patrick Murdock for that purpose; exhibiting his very neat and accurate manner of writing and arranging his figures, not to be equalled perhaps by the best penman now living.

The late ingenious Mr. Smeaton says, (Philosophical Transactions, anno 1786, p. 5, &c.): "In the year 1689, Mr. Flamsteed completed his mural arc at Greenwich; and, in the Prolegomena to his Historia Cœlestis, he makes an ample acknowledgment of the particular assistance, care, and industry of Mr. Abraham Sharp; whom, in the month of August 1688, he brought into the observatory as his amanuensis; and being, as Mr. Flamsteed tells us, not only a very skilful mathematician, but exceedingly expert in mechanical operations, he was principally employed in the construction of the mural arc; which in the compass of fourteen months he finished, so greatly to the satisfaction of Mr. Flamsteed, that he speaks of him in the highest terms of praise.

"This celebrated instrument, of which he also gives the figure at the end of the Prolegomena, was of the radius of 6 feet, 7½ inches; and, in like manner as the sextant, was furnished both with screws and diagonal divisions, all which were made by the accurate hand of Mr Sharp. But yet, whoever compares the different parts of the table for conversion of the revolutions, and parts of the screw belonging to the mural arc, into degrees, minutes, and seconds, with each other, at the same distance from the zenith on different sides, and with their halves, quarters, &c. will find as notable a disagreement of the screw-work from the hand divisions, as had appeared before in the work of Mr. Tompion; and hence we may conclude, that the method of Dr. Hook, being executed by two such masterly hands as Tompion and Sharp, and found defective, is in reality not to be depended upon in nice matters.

"From the account of Mr. Flamsteed it appears also, that Mr. Sharp obtained the zenith point of the instrument, or line of collimation, by observation of the zenith stars, with the face of the instrument on the east and on the west side of the wall; and that having made the index stronger (to prevent flexure) than that of the sextant, and thereby heavier, he contrived, by means of pulleys and balancing weights, to relieve the hand that was to move it from a great part of its gravity. Mr. Sharp continued in strict correspondence with Mr. Flamsteed as long as he lived, as appeared by letters of Mr. Flamsteed's found after Mr. Sharp's death, many of which I have seen.

"I have been the more particular in what relates to Mr. Sharp, in the business of constructing this mural arc, not only because we may suppose it the first good and valid instrument of the kind, but because I look upon Mr Sharp to have been the first person that cut accurate and delicate divisions upon astronomical instruments, of which, independently of Mr Flamsteed's testimony, there still remain considerable proofs; for, after leaving Mr. Flamsteed, and quitting the department above mentioned, he retired into Yorkshire, to the village of Little Horton, near Bradford, where he ended his days about the year 1743 (should be in 1742), and where I have seen not only a large and very fine collection of mechanical tools, the principal ones being made with his own hands, but also a great variety of scales and instruments made with them, both in wood and brass, the divisions of which were so exquisite, as would not discredit the first artist of the present times; and I believe there is now remaining a quadrant, of four or five feet radius, framed of wood, but the limb covered with a brass plate, the subdivisions being done by diagonals, the lines of which are as finely cut as those upon the quadrants at Greenwich. The delicacy of Mr. Sharp's hand will indeed permanently appear from the copper-plate in a quarto book, published in the year 1718, entituled 'Geometry Improved, by A. Sharp, Philomath,' (or rather 1717, by A. S. Philomath,) whereof not only the geometrical lines upon the plates, but the

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whole of the engraving of letters and figures were done by himself, as I was told by a person in the mathematical line, who very frequently attended Mr. Sharp in the latter part of his life. I therefore look upon Mr. Sharp as the first person that brought the affair of hand division to any degree of perfection"

Mr. Sharp kept up a correspondence by letters with most of the eminent mathematicians and astronomers of his time, as Mr. Flamsteed, Sir Isaac Newton, Dr. Halley, Dr. Wallis, Mr Hodgson, Mr. Sherwin, &c. the answers to which letters are all written upon the backs or empty spaces of the letters he received, in a short hand of his own contrivance. From a great variety of letters (of which a large chest-full remains with his friends); from these and many other well known facts it is evident, that Mr Sharp spared neither pains nor time to promote real science. Indeed, being one of the most accurate and indefatigable computers that ever existed, he was for many years the common resource for Mr. Flamsteed, Sir Jonas Moore, Dr. Halley, and others, in all sorts of troublesome and delicate calculations.

Mr. Sharp continued all his life a bachelor, and spent his time as recluse as a hermit. He was of a middle stature, but very thin, being of a weakly constitution; he was remarkably feeble the last three or four years before he died, which was on the eighteenth of July 1742, in the ninety-first year of his age.

In his retirement at Little Horton, he employed four or five rooms or apartments in his house for different purposes, into which none of his family could possibly enter at any time without his permission. He was seldom visited by any persons, except two gentlemen of Bradford, the one a mathematician, and the other an ingenious apothecary: these were admitted, when he chose to be seen by them, by the signal of rubbing a stone against a certain part of the outside wall of the house. He duly attended the dissenting chapel at Bradford, of which he was a member, every Sunday; at these times he took care to be provided with plenty of halfpence, which he very charitably suffered to be taken singly out of his hand, held behind him during his walk to the chapel, by a number of poor people who followed him without his ever looking back, or asking a single question.

Mr. Sharp was very irregular as to his meals, and remarkably sparing in his diet, which he frequently took in the following manner. A little square hole, something like a window, made a communication between the room where he was usually employed in calculations, and another chamber or room in the house where a servant could enter; and before this hole he had contrived a sliding board: the servant always placed his victuals in this hole, without speaking or making the least noise, and when he had a little leisure, he visited his cupboard, to see what it afforded to satisfy his hunger or thirst. But it often happened that the breakfast, dinner, and supper, have remained untouched by him, when the servant has gone to remove what was left, so deeply engaged had he been in calculations Cavities might easily be perceived in an old English oak table where he sat to write, by the frequent rubbing and wearing of his elbows. *Gutta cavat lapidem*, &c By Mr. Sharp's epitaph it appears that he was related to Archbishop Sharp; and Mr. Sharp, the eminent surgeon, who some years since retired from business, is the nephew of our author. Another nephew was the father of Mr. Ramsden, the present celebrated instrument maker, who says that his grand uncle, Abraham, our author, was some time, in his younger days, an exciseman, which occupation he quitted on coming to a patrimonial estate of about two hundred pounds a-year

SHASTER, or SHASTRAM, a sacred book, containing the religion of the Banians; it consists of three tracts; the first of which contains their moral law; the second, the ceremonial; and the third, delivers the peculiar observances for each tribe of Indians.

SHAWIA, in botany, so named in memory of Thomas Shaw, D. D. a genus of the Syngenesia Polygamia Segregata class and order. Essential character: calyx imbricate, with five or six scales, three interior longer; corolla five-cleft; seed one, oblong. There is only one species, *viz* S. paniculata, a native of New Zealand

SHEADING, a term used in the Isle of Man for a riding, tything, or division of that isle; the whole being divided into six of these sheadings; in each of which there is a coroner or constable, who is appointed by the delivery of a rod at the tinewald court, or annual convention.

SHEATHING, in ship-building, a sort of casing or covering, nailed all over the outside of a ship's bottom, to protect the planks from the pernicious effects of the worms. It has been customary many years

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past to sheath the ships of the Royal Navy, and those of the East India service, with copper.

SHEAVE, or Sheeve, in maritime affairs, the wheel on which the rope works in a block; it is generally formed of lignum-vitæ, sometimes of brass, and frequently compounded of both: the interior part, or that which sustains the friction against the pin, being of brass, let into the exterior, which is of lignum-vitæ, it is then denominated a sheave with a brass bush.

Sheave *hole*, is a channel cut in a mast, yard, or timber, in which to fix a sheave, and answering instead of a block.

SHEEP, in zoology, a well-known genus of quadrupeds, the horns of which are hollow, bent backward, twisted, and rugose; the fore-teeth are eight, and the hinder ones are narrower than the others: there are no canine or dog-teeth. See Ovis.

Sheep. Any person who shall feloniously drive away, or feloniously steal any sheep or lamb, or wilfully kill any sheep or lamb, with a felonious intent to steal the carcase, or any part thereof, or assist or aid in committing any of the said offences, shall be guilty of felony, without benefit of clergy. 14 George II c. 6. Any person who shall apprehend and prosecute to conviction any such offender, shall have a reward of 10*l.*; for which purpose he shall have a certificate, signed by the judge before the end of the assizes, certifying such conviction, and where the offence was committed, and that the offender was apprehended and prosecuted by the person claiming the reward; and if more than one claim it, he shall therein appoint what share shall be paid to each claimant. And on tendering such certificate to the sheriff, he shall pay the same within a month, without deduction, or forfeit double, with treble costs; to be allowed in his accounts, or be repaid him out of the treasury. And any person who shall in the night time maliciously and wilfully maim, wound, or otherwise hurt any sheep, whereby the same is not killed, shall forfeit to the party grieved treble damages, by action of trespass, or on the case.

By 28 George III. c 38, every person, who shall export any live sheep or lambs, shall forfeit 3*l.* for every sheep or lamb, and shall also suffer solitary imprisonment for three months, without bail, and until the forfeiture is paid, but not to exceed twelve months for such non-payment; and for every subsequent offence 5*l.* a piece, and imprisonment for six months, and until the forfeiture be paid; but not to exceed two years for the non-payment thereof. And all ships and vessels employed in the exportation of sheep shall be forfeited.

Sheep *shank*, in naval affairs, a kind of knot made on a rope to shorten it, and particularly used on runners or ties, to prevent the tackle from coming block and block. By this contrivance, the body to which the tackle is applied may be hoisted much higher, or removed further, in a shorter time.

SHEERING, or Shearing, in the woollen manufacture, is the cutting off, with large sheers, the too long nap, in order to make the cloth more smooth and even.

Sheering, in the sea language: when a ship is not steered steadily, they say she sheers, or goes sheering; or, when at anchor, she goes in and out, by means of the current of the tide, they also say she sheers.

SHEERS, in naval affairs, an engine used to hoist in, or get out the lower masts of a ship. They are either placed on the side of a quay or wharf, or are fixed on board of an old ship cut down; or, lastly, they are composed of two masts, or large spars lashed together, and erected in the vessel, in which the mast is to be placed or displaced; the lower ends of the props resting on the opposite sides of the deck, and the upper parts being fastened together across, from which a tackle depends.

SHEET, in naval affairs, a rope fastened to one or both of the lower corners of a sail, to extend and retain it in a particular situation. When a ship sails with a side wind, the lower corners of the main and fore-sails are fastened by a tack and sheet, the former being to windward, and the latter to leeward; the tack is, however, only diffused with a stern wind, whereas the sail is never spread without the assistance of one or both of the sheets. The stay-sails and studding-sails have only one tack and one sheet each; the stay-sail tacks are fastened forward, and the sheets drawn aft, but the studding-sail tacks draw the outer corner of the sail to the extremity of the boom, while the sheet is employed to extend the inner corner.

SHEFFIELDIA, in botany, so named in honour of Mr. Sheffield, an eminent botanist, of the University of Oxford, a genus of the Pentandria Monogynia class and order. Natural order of Caryophyl-

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lei. Lysimachiæ, Jussieu. Essential character: calyx five-cleft; corolla bell-shaped; filaments ten, the alternate ones barren; capsule one-celled, five-valved, many-seeded. There is only one species, *viz.* S. repens, a native of New Zealand and Easter Island.

SHEKEL, in Jewish antiquity, an ancient coin, worth about 2*s.* 3½*d.* sterling.

SHELF, among miners, the same with what they otherwise call fast ground, or fast country; being that part of the internal structure of the earth which they find lying even, and in an orderly manner, and evidently having retained its primitive form and situation, unmoved by the waters of the general deluge, while the circumjacent and upper strata have plainly been removed and tossed about.

SHELL, a substance of a stony hardness, composed of carbonate of lime, variously combined with animal gluten, and serving for the coverings and habitations of different animals, mostly of the order of Mollusca; allowing of the occasional protrusion of part of their naked body. The various forms, the beautiful colours, and the high polish, which shells possess, have long rendered them objects of research to the curious naturalist; many of them possessing these properties in a high degree; and being from their rarity purchased at very high prices.

The vast variety of forms which shells possess not only renders arrangement more necessary, but at the same time occasions the formation of that arrangement the more difficult. Dissimilarity in size and colour, as well as in form, which occur in shells of the same species, at different ages, adds much to this difficulty. External characters, however, sufficiently marking specific differences, may almost always be discovered in shells, at every period of their existence; and various attempts have hence been made to dispose them in such a methodical arrangement, as should place each of them in its proper place; and should thereby occasion them to be more readily recollected.

Lister, Langius, and other early writers on testaceology, have proposed different methodical arrangements of shells, which, from their imperfections, have been entirely laid aside, and do not, therefore, require to be here noticed. Indeed it appears to be unnecessary to go further back than to the arrangement of the celebrated Linnæus, which seems, in its turn, to be yielding to later systems, rendered more perfect by the constant accession of new and illustrative specimens, and the consequent increase of knowledge. But previous to considering the proper method of arrangement, and to examine into even the generic differences, it will be proper to ascertain the characters which belong to shells in general, and to determine the precise terms by which they can be best expressed.

The division into univalves, bivalves, and multivalves, is so clearly pointed out by nature, that it must be adopted in every well methodized arrangement, and may therefore be safely admitted in these preliminary observations. Univalve shells are discoidal, when the spiral is formed on a horizontal line, so that a section, made in that line, would divide the shell into two nearly equal parts; fusiform, when it bulges in the middle, and has the two extremities of nearly equal length: turbinated, when the belly of the shell is very large and tumid, compared with the spire which is given off from its centre; and turriculated, when the turns of the spire gradually increasing, form an elongated cone.

The parts of univalve shells are, the back, which is the external bulging part of the turn opposite to the opening: the belly, the tumid part of the last turn, forming the right or outer lip; that being termed the left which is formed on the columella, and which Linnæus distinguished as the columellar ridge. The spire is formed on the superior part of the shell, the turns of which are formed round the columella, or little central column, reaching from the opening of the shell to the summit of the spire. These convolutions are numbered by reckoning that as one, which reaches from the external to the inner lip, and in the same manner to the summit; the line by which they are united being termed a suture. The spire itself is either pointed, obtuse, truncated, flattened, concave, convex, straight, oblique, or pyramidal. Its turnings are coronated, (beset with spines or tubercles,) beaded, carinated, or canaliculated. The suture is crenulated, double, projecting, or effaced. The shell is said to be perforated when a small umbilical cavity exists in the columella at the base of the shell, in the axis round which the spire is revolved; and imperforate, when there is here no cavity nor umbilicus. Besides being either umbilicated or not, the columella may be flattened, truncated, caudated, canaliculated, spiral, and plaited, as in the Volutes. The umbilicus also may

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be slit, canaliculated, consolidated, crenulated, or dentated: it may also have a superadded cullus. The opening varies much in different shells; and where it narrows it acquires the name of throat; it terminates in a canal. The lip is eared, digitated, alated, grooved, slit, or wrinkled; the form of the opening depending much on that of the lip; it hence becoming angular, round, semicircular, longitudinal, transverse, linear, gaping, compressed, or reversed. The openings of shells are sometimes closed by a shelly or cartilaginous plano-convex body, termed operculum, which is disposed between the two lips, and fitted to the form of the opening. The flat surface of this body is marked by a spiral line.

A bivalve shell has the two valves which constitute it connected at the basis, or inferior margin: opposite to which is the superior margin: the shell being supposed to be placed on the hinge, its margin is divided into the anterior and the posterior margin. The length of the shell is measured from the inferior to the superior margin, and the breadth from the anterior to the posterior margin. The belly is the most tumid part, and the beaks, the prominences over the hinge, are of a conoidal and spiral form. At the basis of the shell is the hinge, by which the valves are moved on each other; and in the anterior chink a ligament is placed, by which the valves are closely connected. This chink is formed by a slight separation of the valves at this, the anterior part, which having a distinct surface from the general disk, and being indeed separated from it by an angle, or by a raised or sunk line, it may be distinguished as the corslet; this surface is particularly distinguished in the shells of the Venus kind. On these parts, in some species, are spines, in others various markings, and in others these parts are plain. At the lower part of the anterior margin of the valves, within the limits of the corslet, and above the ligament, is a part generally distinguishable from the rest of the surface by a difference in the colour, striæ, &c. This part varies in its form, being canaliculated, replicated, &c. Its edges are termed lips.

On the other side of the hinge, on the posterior part, and near the hinge, is generally a lunated depression; the crescent, like the part just described, varies in its form and markings in different shells. Both these parts derive half their form from each of the valves; and are consequently separated in the middle. To determine the side to which a valve belongs, the shell need only be placed on the hinge, with the anterior side forward, when it directly shows itself.

In some irregular shells, as of oysters, and spondyles, the shells are divided into upper and under, the upper shell being flatter than the under. In the Terebratulæ, the upper shell, the beak of which is pierced, is more tumid than the under: but in most shells, as in the Pectens, and the oysters, the upper valve is almost always the least tumid.

The hinge is, in general, furnished with teeth; but sometimes it is without. When placed on the side, they are said to be lateral; and when on the inferior extremity, terminal. The central teeth, essential to the genus, are termed the cardinal teeth; and the others, accessory or secondary. The teeth are in some shells articulated, in a cavity, in the opposite valve; in others, they are not. In multivalves also the shell is the combination of all the valves, whether connected by articulation, or by ligaments.

From the observations and experiments of Reaumur, which have been since considerably extended by Bruguiere and others, the formation and growth of shells have obtained considerable illustration. Leuwenhoeck, Swammerdam, Lister, and others, had observed, that, at the first escape of the animal from the egg, it was invested by a complete spiral turn, at least of the shell: and it appears, from the observations of Adanson, that viviparous shell-fish are likewise brought forth in a similar state. The growth of shells was discovered by Reaumur to take place in that which is most distant from the first formed part. Here a part of the animal exists, which is not yet covered with shell, but which is beset with a vast number of vessels, which separate, and deposit on the existing edge of the shell those glutinous and calcareous matters, by which its due increased extent of surface is obtained. In proof of this being the process by which the augmentation of the shell is effected, he broke the shells of various living testaceous animals in different parts, and was thus enabled to perceive, that the newly added matter was not deposited line after line from the shell, at the edges of the fractured part; but was separated, in a pellicle, from the body of the animal, and thus applied at once to the whole of the vacuity. Those, who denied this mode of increase, denied also the removal of the posterior termination of

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the worm, from the extreme termination of the first formed spire. But it is certain, that the animals in many shells have their posterior termination attached to the point of the shell only in their earliest stages; and that, when older, it is found adherent to the second or third turn: and it has also been ascertained that the tail of the Nerite is attached beneath the left or columellar lip. In proof of these animals possessing this power of removing themselves from these turns of the shell, or indeed from those parts in which their residence is no longer necessary, the circumstance may be adduced of the animal belonging to the Porcellanea, sometimes abandoning its old shell, and forming a new one.

The various tints of different colours with which shells are so beautifully adorned, result, according to the remarks of the same ingenious naturalist, from an economy and organization somewhat similar to that which has been just mentioned. On the neck of the animal, that part from which the matter of the shell is supposed to be secreted, the colours of the shell may be detected. Thus, if the ground of the shell be yellow, and it be marked with dark brown or black bands, then the neck of the animal will be seen of a white, inclining to a yellow hue, with dark spots, answering in their number and direction to the bands observable in the shell itself: the colouring matter appearing to be here disposed, ready for its deposition, with the other substances of the shell. In this manner, and on these principles, has Reaumur been able to explain almost every circumstance, respecting the varieties of form and of colour which are observable in these bodies.

But a circumstance is observable in the Olives and the Porcellaneæ, to which Reaumur has not attempted to apply his doctrine. In these shells the colours are disposed in two layers, the outer of which is the production of an organization different from that of any of the other inhabitants of shells, and from which proceeds an operation, also different from what occurs in any other instance. At the period at which Reaumur wrote, several of the olives and of the cowries, in consequence of certain differences of colour, and of some difference also in their forms, were considered as of different species from others, of which they were in fact individuals of the same species, but had not yet acquired their perfect state. For want of reckoning upon this circumstance, the celebrated Linnæus has unnecessarily multiplied the number of species of these shells.

The highly ornamented surface of these shells is formed at two different periods, and by two different processes. The first appears to be that deposition which takes place from the surface of the body of the animal; and in which but little takes place different from what occurs in shells in general. But as the age of the animal advances, this surface is covered by another; the primitive colours disappear, others are disposed over them, and the substance itself of the shell becomes considerably thickened. This process is performed by a simple, but most curious organization. Two soft, membraneous flaps, or winged processes, pass out of the opening of the shell, turn back on the external convex surface, and cover it so completely as not to leave the least portion to be seen at the line where they meet each other, on the back of the shell. From the superior surface of these membraneous bodies, that surface which clings to the convex part of the shell exudes that secretion, by which the shell is increased in bulk; and a new arrangement of the beautiful colours of its drapery is effected.

Brugulere ascertained this formation of a second surface by actual observation at Madagascar; and the fact derives additional proof from the pale line which passes frequently along the back of these shells, marking the part where the edges of the membraneous wings met. Still more positive proof is rendered by rubbing down the second coat, when the markings of the first coat will make their appearance.

Although the colours are thus disposed by the animal, the action of light appears to have a considerable effect in augmenting their brilliancy; climate also occasions considerable differences in this respect; hence the shells obtained from the torrid zones are much more rich in their colouring than those which are found in the more temperate zones. But notwithstanding the circumstance just noticed, there is great reason for attributing the high degree of colouring in shells more to the effects of light than to the heat of the climate.

It is not the colouring only of the second coat of the porcellaneous shells which is given by this second operation; the several asperities observable in various shells, as in the Cypræa tuberculosa, and in the Cypræa pediculus, are superadded at the same period.

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The form of the shell will necessarily depend on that with which the worm is first invested; but it is a curious subject of investigation, on what peculiar modification of the animal depends the spiral form of univalve shells. This has been attempted to be explained by Reaumur, by a very simple peculiarity of organization; it being sufficient, he supposes, to consider the fibres on one surface of the body to be shorter than those on the opposite surface. From this inherent peculiarity of formation, the prolongation of the animal must necessarily be in a spiral form; and from the various obliquities of disposition of these shorter and longer fibres will proceed that variety of direction, in which the spiral turns will be disposed.

The umbilicus, the cavity in the centre of the spire, which is seen in the lower part of the shell, depends on the direction in which the animal has extended the shell. Thus, if the turns of the spire have been carried round an axis of a conical form, each turn having departed more and more from the centre of the shell, an umbilicus will be formed, more or less open, as the terms depart more or less from the centre. But if the terms are made round an axis so straight and fine as to occasion the turns to touch each other, then no umbilical cavity will be formed at the bottom of the shell.

To enable us to account for the longitudinal, raised and thickened ribs, which cross, in a longitudinal direction, the turns of the spire, and which are termed varices by Linnæus, it is necessary to refer to the formation of the opening of land shells, when they have obtained their full growth. At this period the lip of the shell, from the frequent egress and return of the animal through the opening, has an additional portion of the testaceous matter repeatedly deposited upon it, by which it acquires a bordered edge, which differs in size and thickness in the shells of different animals. But in sea-shells, the growth of the shell is not completed on the formation of this bordered lip; the continuation of the spire still proceeding after its formation. To explain the formation of these ribbed longitudinal projections, it is therefore only necessary to suppose the animal, after having formed the bordered edge to the mouth of the shell, to have proceeded uninterruptedly for a certain period in the formation of the common smooth surface of the shell, which as it would then extend beyond the lately formed lip, would now render it a rib projecting from the general surface; and by a repetition of this process, a succession of these ribs, with intermediate spaces of the common surface, such as frequently exists in turbinated shells, would consequently be formed.

From a process exceedingly similar, we may suppose the formation of the warted protuberances and tubercles to have proceeded; corresponding fleshy projections, existing on that part of the surface of the animal to which this part of the shell has been applied, having been the moulds, as it were, on which these have been formed. Whilst these fleshy protuberances have continued, these processes have remained hollow; but where the fleshy protuberances have been diminished, these processes have become partly filled up; and where they have been removed, these have become entirely solid, from the deposition of additional shelly matter from the surface of the animal, the existence of the cavities being necessary no longer than the continuance of the fleshy processes themselves.

The production of the spinous processes, so frequent on many shells, approaches still nearer to that of the ribbed protuberances, since they have been formed by little, long, tongue-like processes, with which the neck of the animal is beset, and which have served in the same manner to produce these spines, as the neck of the animal has served to form the bordered edge of the shell, by an addition of the testaceous matter at each time the neck of the animal, at certain periods, passed out or returned into the shell. The confirmation of this being the mode of their formation is yielded, by the circumstance of these spines being ranged in lines, at equal distances, on the ribbed protuberances, or varices of Linnæus, the formation of which has not only been similar, but simultaneous.

The production of the channel, or gutter, (the cauda of Linnæus,) depends on circumstances extremely similar to those on which has depended the formation of the various parts already noticed. All those animals whose shells have this termination, are endued with an organ of a cylindrical form, capable of being contracted and extended, so as to allow the animal to explore its path, or to attach itself to neighbouring bodies. By the frequent employment of this organ, and by its necessarily accompanying frequent alternate contractions and extensions, its surface, which possesses the property of exuding a testaceous substance, must at

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each passage and return contribute to the formation of this canal, which would serve the purpose of a sheath to it.

By an ingenious application of these principles of Reaumur, Brugulere and Brogniart ("Bulletin de la Societé Philomathique," No. 25.) have very satisfactorily explained the production of the several fissures, striæ, grooves, and other modifications of the forms and surfaces of different shells. The author last mentioned has shown, that, in some instances, the organ by which some changes have been produced in the later formed part of the shell was not acquired by the animal until it had obtained its full size. By an application of these principles to bivalves, and even to multivalves, their peculiarities of form have also been very ingeniously accounted for. It has been found, that, in bivalves, the part of the animal which is termed the mantle is the organ on which the peculiarity of the form of each chiefly depends; it answering in this respect to the collar, or neck of the animal, belonging to univalve shells.

It does not seem necessary here to dwell on the labours of those, who, previous to the time of Linnæus, had endeavoured to dispose of shells under the most comprehensive and distinctive arrangement. Whatever had been done before with this view gave way to the more lucid and correct disposition which Linnæus adopted; but this is certainly by no means the *ne plus ultra*: other divisions appear in some instances deserving of adoption, and new genera require to be admitted. It is, therefore, intended to give here Linnæus's arrangement of the genera, omitting the species; afterwards to give that which has been adopted by Du Bosc, agreeable to the discoveries and observations of Lamarck, Brugulere, and others; and to offer a few explanatory remarks, for the purpose of showing the propriety or impropriety of the deviations from the arrangement of Linnæus.

MULTIVALVE SHELLS.

Genus 1. Chiton. The animal covered by several shells lying on each other along the back.

2. Lepas. The shell, which is formed of several unequal and erect valves, is affixed by its base.

3. Pholas. Shell bivalve and divaricated, with smaller, accessory, differently formed pieces at the hinge.

BIVALVES, OR CONCHÆ.

4. Mya. Gaper. Shell generally gaping at one end; the hinge with, for the most part, a thick, solid, spreading tooth, not inserted in the opposite valve.

5. Solen. Razor-shell. Shell oblong, gaping at both ends; hinge with a subulated reflexed tooth, often double, not inserted in the opposite valve: the lateral margin rather obsolete.

6. Tellina. The foreside of the shell sloping downwards; the hinge, in general, with three teeth; the side teeth, in one of the valves, being either flat or wanting.

7. Cardium. Shell with equal and nearly equilateral valves, longitudinally ribbed, or sulcated, the margin dentated; the hinge having, in the middle, two alternating teeth, one commonly incurved, and two lateral, remote teeth, inserted into each other.

8. Mactra. Shell with equal, but inequilateral valves; the hinge a complicated, central tooth, with an adjoining pit, and remote lateral teeth, inserted in the opposite valves.

9. Donax. The anterior margin of the shell very obtuse, the margin often crenulated, two teeth at the hinge, and on the hinder margin a single one, (rarely two, or three, or none,) somewhat remote.

10. Venus. The lips lying over the anterior margin; the hinge with three teeth close together, the lateral ones diverging from the apex.

11. Spondylus. With rigid, unequal valves; the hinge being formed by two recurved teeth, with a cavity between.

12. Chama. The shell heavy; the hinge a gibbous projection, inserted in an oblique cavity; the fore parts closed, without cartilages.

13. Arca. Equivalved; the hinge with numerous, acute, and alternately inserted teeth.

14. Ostrea. With unequal valves, sometimes eared; the hinge an ovate cavity, without teeth, but, in general, with lateral transverse striæ; no space or depression at the ligament.

15 Anomia. The valves unequal, one flattish, the other gibbous, and one of them often perforated at the base; the hinge a linear projection, with a lateral tooth, which, in the flat valve, is inserted in the margin; two bony rays support the animal.

16. Mytilus. Shell coarse, generally affixed by its byssus; hinge generally

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without teeth, being distinguished by a linear, subulated, longitudinal, furrow.

17. Pinna. A sub-bivalve, brittle, erect, and gaping, having a silky beard. The hinge without teeth; the valves adhere on one side.

UNIVALVE SHELLS, OR COCHLEÆ.

18. Argonauta. Shell spiral, involute, membranaceous, and with one chamber.

19. Nautilus. Divided into many chambers, by partitions, perforated with projecting pipes.

20. Conus. Convoluted and turbinated shell; the aperture longitudinal, linear, open at both ends, and without teeth; the base entire, and the columella smooth.

21. Cypræa. Involuted, sub-ovate, obtuse, and smooth; the opening longitudinal, linear, dentated on each side, and extended to both ends of the shell.

22. Bulla. Convoluted, without spire, opening longitudinal, oblong, and contracted at the ends, entire at the base; the columella oblique and smooth.

23. Voluta. Unilocular and spiral; the aperture without a tail, and somewhat open at both ends: columella plaited, with no inner or columellar lip, nor umbilicus.

24. Buccinum. Spiral and gibbous; the aperture oval, terminating in a gutter, which, with the cauda, runs out to the right; the interior lip smooth.

25. Strombus. Spiral, with one side large, the aperture frequently with a dilated outer lip, terminating in a gutter which turns to the left.

26. Murex. Spiral and rough, with membranaceous sutures; the aperture ending in an entire, straight, or somewhat ascending gutter.

27. Trochus. Spiral, and nearly conical; the aperture nearly tetragonal or rounded, contracted transversely above; the columella oblique.

28. Turbo Spiral and solid; the aperture contracted, orbicular, and entire.

29. Helix. Spiral, subdiaphanous and fragile; aperture close at the ends; within lunated, or partly circular, as if a segment of the circle had been cut off.

30. Nerita. Spiral, gibbous, and flattish below; the aperture semiorbicular, or semilunar; the lip of the columella transverse and flattishly truncated.

31. Haliotis. Ear-shaped; the mouth spread open; the spire lateral and flattened; the disk almost always perforated with a row of holes.

32. Patella. Nearly conical, and without a spire.

33. Dentalium. Tubular, straight, with one chamber, open at both ends.

34. Serpular. Tubular, adhering to other bodies, often intercepted by entire partitions.

35. Teredo. Round, bending, and lodged wood.

36. Sabella. Tubular, formed by grains of sand, on a membranous sheath.

The French naturalists, whose late exertions have added much to the funds of this science, have thought it necessary to adopt some changes with respect to the preceding arrangement. These changes would, indeed, derive some support from the high characters which have suggested them; no one having done more of late years to the advancement of this species of knowledge than Bruguiere and Lamarck. Their observations shall therefore be introduced under the several genera to which they apply, whilst the order in which they are taken shall be that of Bosc, in "Histoire Naturale des Coquilles."

MULTIVALVE SHELLS.

Lamarck thinks that Pholades should be regarded as bivalves, having accessary pieces, and that the Oscabrius (Chitons) should be considered as naked molluscæ, whose backs are beset with small testaceous laminæ. Bosc, however, in conformity with accustomed practice, considers them among the multivalve shells

Dacosta (Conchology, 8vo. p. 97.) observes, that "The Greek name lepas, always synonymous with the Latin name patella, the latter signifying little sacrifice dishes, or saucers. was given to limpets from the earliest Grecian times, and the Roman name from their resemblance to those little dishes; yet Linnæus wantonly transposes the name of Lepas to the Balani." The French naturalists have still continued the name of Lepas to the Patellæ; and have separated those bodies which Linnæus had placed under the genus Lepas into two genera: 1. Anatifa, a cuneiform shell, composed of several flat unequal valves, connected together by a membrane, and united to the extremity of a tendinous tube fixed by its base; and, 2. Balanus, a conical multivalve shell, fixed by its base, and composed of six articulated valves, the openings closed by an operculum, with four valves. These

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shells had been united by Linnæus under one genus, most probably in consequence of the similarity of the animals by which they are inhabited; but the French naturalists observe, in confirmation of the propriety of the distinction which they have adopted, that very essential differences exist between the animals of the Anatifæ and of the Balani.

The Teredo is considered by Bosc as a multivalve shell, formed of five unequal pieces; the largest is a cylindrical tube, in which the others are contained. Two extremely thin and nearly hemispherical pieces, resembling parts of a Pholas, pointed at one of their ends, and beset on their outer surface with twenty-five rows of small teeth, like those of a file, are placed at their lower extremity, and by their action remove the wood, and form the cavity in which the shell becomes lodged. At the superior extremity, that which communicates with the water, are two small roundish pieces, connected with the animal by cylindrical pedicles about their own length. When the animal stretches a little out of the tube, these valve-like pieces spread out, and when it re-en ers, they contract, and close the opening, through which the head, or rather the syphons of the animal had passed.

Brugulere has, apparently with much propriety, introduced a new genus, which he has termed Fistulana, the characters of which are a tubular club-formed shell, open at its smaller extremity, and containing in its cavity two valves. The shell, the examination of which led to this separation, is the Hercules club, considered by Gmelin as a Teredo, and named by him Teredo clava. The shells of this genus seem to differ from the Teredines only in containing one, whilst the Teredo contains two pair of valves. The Pholas hians and Pholas teredula of Gmelin appear to be merely the interior valves of two species of Fistulanæ.

From the several species which Linnæus has collected under his genus Anomia, Lamarck and Brugulere have formed six distinct genera, which they have named Anomia, Calceola, Terebratula, Crania, Placuna, and Hyalæa, which they describe as being thus characterized.

Anomia, an irregular shell, formed of two unequal valves, the inferior of which is either pierced or grooved at its beak, the opening being closed by a small operculum, or third valve, which fixes on other bodies, and is attached by a ligament. The hinge is without teeth. It is by possessing this third body, therefore, whether considered as valve or operculum, that this genus is distinguished.

BIVALVE SHELLS.

Calceola. A regular bivalve shell, with unequal valves, the largest being in the form of a half sandal, and the smallest flat, semiorbicular, and resembling an operculum; the hinge with from one to three small teeth. This shell is only known as a fossil, and is considered by Gmelin as an Anomia (Anomia sandalium). It is very thick, and about an inch in length. Its back is flattened; its interior is striated longitudinally, and its valve, or operculum, concentrically.

Terebratula, a regular bivalve shell, with unequal valves, fixing itself by a ligament or short tube; the largest valve perforated at its summit, which is prominent and recurved; hinge with two teeth. The regularity of the valves, the absence of any operculum, the position of the hole, and the form of the hinge, separate this genus from that of Anomia.

Crania, a regular bivalve shell, with unequal valves, the inferior almost smooth, and nearly round, and pierced in its internal face with three unequal and oblique holes; the superior valve very convex, furnished internally with two projecting callosities. The three holes in the inferior valve of this shell induced Lamarck and Brugulere to separate it from the Anomiæ, and place it in a distinct genus. The species described by Linnæus is named by him Anomia craniolaris.

Placuna, an irregular bivalve flat shell; the interior hinge composed of two divering ridges, which serve for the attachment of a ligament. Linnæus has arranged two species, Anomia placenta, and Anomia sella, under the genus Anomia.

Hyalæa, a regular bivalve shell, with unequal, bulging connées, transparent valves, gaping under the beak, and tricuspidated at the base. This genus is formed by Lamarck, from a shell described by Forskal, and denominated in Gmelin's Linnæus Anomia tridentata, caudata, and retusa. The Clyo pyramidata of Linnæus are also referable to this genus.

Lingula, a long flat shell, formed of two valves, nearly equal, truncated in the forepart; the hinge without teeth; the beak of the valves pointed, and joined to a tendinous tube, which is a ligament to

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the shell, and fixes it to other solid bodies. Linnæus, who knew only of one valve of this shell, termed it Patilla unguis.

Corbula is an unequal-valved, subtransverse, smooth, regular shell; with a conical cardinal tooth, curved or turned upwards, on each valve; interior ligament, and two muscular impressions. This genus is characterized by the inequality of its valves, one of them being nearly a third larger than the other. These shells are found fossil at Grignon, near to Versailles.

Orbicula is a genus formed by Lamarck from a shell which was discovered by Muller, and which was named by him Patella anomala. Its differing so entirely from Patellæ in being a bivalve, and its being inhabited by an animal totally different from that of the Patella, has induced Lamarck thus to separate it from the genus Patella. This shell is orbicular, but rather flattened, and composed of two valves; by the lowest of which, which is extremely delicate, it adheres to other bodies. Its hinge is not known.

Pandora is a regular inequivalved and inequilateral shell; with two cardinal, oblong, unequal, and diverging teeth, in the upper valve; and two oblong pits in the other valve; and interior ligament, and two muscular impressions. The shell which gives rise to this genus is Tellina inæquivalvis, of Linnæus; the inequality of the valves being the circumstance which is supposed to warrant the separation. This shell is named Pandora margaritacea, by Brugulere.

Lima. An inequilateral-eared bivalve; the valves a little gaping on one side; hinge without teeth; ligament external; beaks separated. This genus is founded chiefly on the Ostrea lima of Linnæus, now named by Brugulere, Lima squamos. The separation of these shells from the Pectens, on the idea of their forming a byssus, whilst the Pectens do not, requires, it should seem, a more accurate knowledge of the habits of the animals which occupy the different Pectens.

Pecten. This, contrary to Linnæus, is adopted by Brugulere as a genus distinct from Ostrea. Its characters are given: a regular bivalve shell; the valves unequal; the hinge without teeth, most commonly eared, with a triangular pit for the ligament. The hinge shutting by a black ligament fixed in this triangular pit, and the different forms of the shells, are the circumstances which are supposed to warrant the proposed separation.

Pedum. The shell from which this genus has been formed, and of which only one species is known, being that which is figured by Chemnitz and Favanne, is semitransparent, unequal-valved, eared; the inferior valve gaping; the beaks separated: hinge without teeth; ligament external, and attached to a long and narrow gutter. The upper valve is striated, and granulated longitudinally; but the under valve is smooth, sharply edged, and hollowed out in one part.

Perna. An irregular, flattish, bivalve shell: the hinge composed of many linear, parallel teeth, disposed in a straight line, across The hinge is closed by a ligament which is attached between the teeth, and which, by its thickness, prevents the teeth from articulating with each other. Ostrea perna, isogona, ephippium, pictum, and legumen, of Linnæus, are placed under this genus.

Avicula. This genus Lamarck forms from Mytilus hirundo, Linnæus, which is the only shell in the genus. He describes it: an irregular, loose shell, a little gaping towards its beaks, and having the valves of unequal size. The hinge callous, without teeth; a little oblong pit, which is marginal and parallel with the edge which supports the ligament.

Malleus. The hammer-oyster of Linnæus, with two other species, from this genus, according to Lamarck, who gives for the characters of the genus: an irregular loose shell, a little gaping near its beaks, having equal valves: a callous hinge, without teeth, having a conical pit, placed obliquely on the edge of each valve. This genus seems to be hardly sufficiently distinguishable from the last; nor does the name of the genus appear to be well adapted, since some of the species no ways resemble a hammer in their form

Vulsella. This genus is formed from the Mya vulsella of Linnæus. The uncertainty with which this shell has been viewed, at different periods, shows the uncertainty of its nature, and the propriety of not placing it under any other genus. Linnæus had once considered it as a Pinna, and Brugulere as an oyster. It is a loose shell, longitudinal, and nearly equivalved, terminating in a very short bent beak; the hinge callous, depressed, and without teeth, of equal elevation on each valve, forming a rounded conical pit for the ligament.

Ostrea. In this genus is comprehended those shells only which are oysters, according to common acceptation. The

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characters of the genus are, therefore, an irregular, adherent, inequivalve shell; the hinge without teeth; an oblong pit, sulcated across, giving attachment to a ligament.

Gryphæa. The shell, for the reception of which this genus was established by Lamarck, was improperly considered as a species of Anomia by Linnæus, and as a species of oyster by Brugulere; to which latter genus it undoubtedly very nearly approximates. It is a loose unequivalved shell; the inferior valve concave, terminated by a beak turned upwards, and bent into an involved spire; the superior valve smaller, like an operculum, the hinge without teeth, but with an oblong and dented pit; and one muscular impression in each valve. Lamarck enumerates eight fossil species of this genus.

Plicatula is a genus formed, by Lamarck, from Spondylus plicatus of Linnæus. It is an angulated shell, with unequal valves and unequal beaks, which are pointed; the edges are in deep plaits; its hinge is formed of two strong teeth on each valve, and an intermediate pit for the reception of the ligament; with one muscular impression on each valve.

Spondylus. In this genus of Linnæus are comprised bivalve, irregularly-formed shells, the hinge of which is formed of two strong hooked teeth, and an intermediate pit for the ligament; in the inferior valve are two thick recurved teeth, with two intermediate rounded cavities to receive the teeth of the other valve, and an elongated pit, in which the ligament is placed; in the superior valve are two exterior cavities for receiving the teeth of the other valve, and two teeth curving backwards, with a pit for the ligament.

Chama. This genus is appointed, by Brugulere and Lamarck, to those shells only which, in particular, possess unequal valves, and are adherent. The characters of the genus therefore are: a bivalve shell, with adhering unequal valves; the hinge composed of one oblique thick tooth, which may be crenulated or rough, and is articulated in a cavity in the opposite valve.

It was necessary, therefore, to establish other genera for the reception of those shells which thus became excluded from the genus Chima. Hence Brugulere formed two new genera; Cardita, having two teeth in the hinge: and Tridacna, possessing the same number, but having the edges of the crescent crenulated and gaping. Lamarck has proceeded still further; he has subdivided the genus Cardita from an isolated tooth, situated, in some species, under the corslet, as in Cardium isocardia, and makes this his genus Isocardia. He also makes another genus Hippopus, the species of which are subtransverse, inequilateral shells; the hinge with two compressed, inverted teeth, the crescent filled up: of this genus is Chama gigax. But it is necessary still further to particularize these new genera.

Cardita, a loose inequilateral shell, the hinge with two teeth, the one at the base of the left valve, and the other longitudinal, parallel with the anterior face.

Hippopus. An inequilateral, subtransverse shell; the hinge with two compressed and inverted teeth; the crescent filled up. Hippopus, it is to be remembered, differs from Tridacna, by having its crenate filled, whilst in Tridacna it is gaping.

Tridacna. An inequilateral subtransverse shell; hinge with two teeth, compressed and inverted; the crescent gaping. The Chama gigas of Linnæus (the Tridacna gigas of Lamarck) is the only species under this genus.

Cardium. This genus remains unaltered by the French naturalists. The characters being, a sub-cordiform shell, with valves dentated on their edges; the hinge with four teeth; two cardinal, approximating obliquely in each valve, and articulating across with their correspondent teeth; the lateral teeth distant, and inverted in the opposite valve.

Acardo. Is a genus very properly established by Commerson. It is founded on two species: the generic characters of which are, a shell composed of two, nearly equal, flat valves; having neither hinge nor ligament; a muscular impression appearing on the centre of each valve.

Radiolites. This is a genus approximating to the preceding, but very properly separated from it by the form of the shell. The shell is of an irregular form, of unequal valves, striated on the outside; the inferior valve turbinated; the superior convex or conical; no hinge nor ligament.

Erodona. This genus was formed, by Daudin, from two shells in the cabinet of Favannes. It is intermediate between the Mya and Mactra It is a subtransverse, bivalve shell, irregular and gaping; one of the valves having a hollow tooth; and the other a pit between two projections; the ligament inserted on the tooth and in the pit.

Mya, is a transverse shell, gaping at both ends: the ligament on the inside;

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the left valve having a cardinal tooth, compressed, rounded, perpendicular to the valve, and giving attachment to the ligament. This is the original genus of Linnæus, from which Brugulere and Lamarck have withdrawn many of the species, to place them under the genera Vulsella, Glycemeris, and Unio; leaving only those sea-shells which have a very projecting cardinal tooth in one of their valves.

Glycemeris. A transverse shell, gaping at both extremities; a protuberant hinge without teeth; the ligament on the outer part. Such is Mya glycemeris of Linnæus.

Solen. A transverse shell, gaping at both extremities: the upper edge straight, or nearly so; two or three teeth at the hinge, furnished by both valves.

Tellina. Considerable confusion has arisen from the admission of species which by no means belong to this genus. Brugulere and Lamarck have divided the Tellens of Linnæus into two new genera. 1. Tellina, a transverse or orbicular shell, with equal valves, with a fold on the anterior side: one or two cardinal teeth, and two separated lateral teeth, as in Tellina virgata. 2. Caspa, a transverse shell, with two teeth in one valve, and one tooth in the opposite valve, shutting between those of the other valve, as in Telfina angulata.

Cyclas. This genus comprehends some shells which Linnæus had associated with Tellens; but which Brugulere and Lamarck have separated from them, from their wanting the fold on the anterior side. The characters are: A suborbicular, or, in a small degree, transverse shell, without fold on the anterior side; the ligament external and bulging; two or three cardinal teeth, and elongated, lamelliform, inserted lateral teeth. They are fresh water shells.

Venus. This genus of Linnæus is formed by shells which are regular, suborbicular bivalves, provided with a crescent and a corslet; three cardinal teeth near together, and sometimes one or two lateral teeth. The valves of this genus are generally pretty gibbous and thick; constantly equal, and nearly of a triangular form Lamarck divides this genus into two. 1. Venus, a suborbicular or transverse shell, with three approximated cardinal teeth, the lateral ones being more or less diverging. 2. Meretrix, a transverse or orbicular shell, with three approximated cardinal teeth, and one isolated tooth under the crescent. The genus Caspa, mentioned above, is proposed by Brugulere and Lamarck to comprise several of the Venus's of Linnæus.

Ungulina. A regularly formed long bivalve; the hinge formed by a very small tooth between two oblique dents: the valves bearing the form of the finger nail. There is but one species in this genus. The hinge bears some resemblance to that of Cardium, but the general form of the shell differs much from that of Cardia.

Donax. A regular, transverse, inequilateral bivalve, with three cardinal teeth, and one or two separated lateral teeth. Shells of this genus have much of the triangular form, their sides very unequal; they are solid, thick, flattened at the inferior, and rounded at the opposite, extremity. The ligament, which, in most shells with equal valves, is placed above the summit, is in these shells unequally distributed above and below it. Above, it is narrow and short; and below, it is thick, nearly round, and fills the cavity of the corslet exactly.

Mactra. A bivalve shell, regular, transverse, inequilateral, and a little gaping, the cardinal tooth having a pit for the ligament; lateral teeth, compressed and inserted, or none.

Lamarck divides this genus into three, 1. Mactra, a transverse, inequilateral shell, a little gaping; the cardinal tooth folded in a furrow, articulating with that of the opposite valve, and accompanying a pit for the ligament; two lateral and inserted teeth, such as Mactra stultorum. 2. Lutraria, a transverse, inequilateral shell, gaping at the extremities; two cardinal teeth, oblique, and diverging, accompanying a large pit for the ligament; no lateral teeth; such is Mactra lutraria, Linnæus. 3. Paphia, a subtransverse, inequilateral shell, the valves close: a pit for the ligament on the beak, between or near to the teeth of the hinge, as in Venus divaricata, Linnæus.

Crassatella. A genus formed by Lamarck of shells unknown to Linnæus, and which Brugulere had placed in the genus Mactra. The generic characters are, an inequilateral, subtransverse shell, with close valves, with a sunk crescent or corslet; the ligament internal; the pit for the ligament placed under the beaks, above the teeth of the hinge. There are two fossil, and one recent species under this genus. These shells are remarkable for the thickness of the valves, and for their two deep muscular impressions.

Trigonia. This is a genus formed by

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Lamarck, the species of which are known only in a fossil shape. The characters of the genus are, an inequilateral subtrigonal shell, the hinge formed by two large, flat, diverging teeth, transversely grooved. These are the Cunei of Dacosta.

Hiatella. A genus formed by Daudin on two shells from Tranquebar, which appear to be intermediate between the genera Trigonia and Tridacna; the characters are, a transverse, irregular bivalve shell, gaping in its superior edge; its hinge a tooth in each valve, inserted in a groove in the opposite valve.

Cucullæa. A gibbous, subtransverse inequilateral shell, with detached beaks: the hinge in a straight line, having a range of numerous teeth, transverse inserted; and at the extremities two or three parallel rib-like teeth, the ligaments external. This genus is founded by Lamarck on a recent shell from the Indian Sea, and on a fossil shell from Beauvais, which Brugulere had placed among the Arks, from which these shells differ in the ribs placed at the extremities of the hinge.

Arca. An inequilateral bivalve shell; the hinge composed of numerous teeth, which lock in the interstices of those of the opposite valve, and which range in a straight, angular, or curved line. The ligament external. This genus of Linnæus has been subdivided by Lamarck into three genera. 1. Arca, with the teeth of the hinge in a straight line, as the Arca noæ. 2. Pectunculus, with the hinge in a curved line; and 3. Nucula, which deserves a distinct notice.

Nucula. This genus has been formed by Lamarck from Arca nucleus, Linn. Daudin has also added two more species. The shells of this genus evidently differ from the Arks, in having their insides resplendent with the mother of pearl, and in having a large tooth at the hinge. The characters are, an inequilateral, almost triangular or oblong shell; the hinge in a broken line, beset with numerous transverse and parallel teeth; one oblique cardinal tooth out of the line; the beaks contiguous, and turned forwards.

Unio. A transverse shell, with three muscular impressions; an irregular, callous cardinal tooth, stretching on one side under the corslet, and articulating with one of the opposite valve. In this genus, formed by Brugulere, are placed the Mya margaritifera and Pictorum of Linnæus.

Anodonta. A regular transverse bivalve shell, having three muscular impressions; a simple hinge without any tooth. In this genus are placed Mytilus cygneus, anatinus, and flaviatilis, of Linnæus, with three other species.

Mytilus. A regular transverse shell with equal valves, shutting close, a hinge without, or with one or two teeth. Lamarck divides the genus Mytilus into four genera. 1. Mytilus, a longitudinal shell, with pointed terminating beaks; one muscular impression, and a hinge most frequently without teeth. 2. Modiolus, a subtransverse shell, the posterior extremity very short; the beaks sunk upon the short side of the shell; one muscular impression; the hinge simple, without teeth. 3. Avicula. 4. Anodonta.

Pinna. The characters of this genus are, a regular bivalve shell, with equal valves, wedge formed, pointed at its base, gaping at its superior edge; hinge without teeth, and lateral ligament very long.

UNIVALVE SHELLS.

Patella. A conical univalve shell, without a spire. Linnæus had divided these shells into five sections; the labiated, the dentated, the mucronated, the entire, and the perforated. Lamarck has divided this genus into five: 1. Patella, a shell of a shield or bonnet form, without a spire, whole at the top, and simple within. 2. Crepidula, an oval shell, with an incomplete spire, inclined on the edge; the cavity separated into two, by a simple diaphragm. 3. Calyptra, a conical shell, whole at the point; with a spiral diaphragm. 4. Fissurella, the shell pierced with a hole at the point. 5. Emarginula, a conical shell, summit inclined, concave beneath, and the posterior edge slit or grooved.

Planospirites. A suborbicular flattish univalve, having in its inferior face, on one side, a cord-like border, turning back in spiral turns on the disk of the shell. The genus is formed by Lamarck on a fossil shell, found by Faujas among the fossils of Maestricht; but the figure has not yet been given.

Testacella. A univalve shell, in form of an oblique cone, the summit being rather spiral and the opening oval. This is the covering of the posterior part of a long gasteropodia from the isle of Teneriffe. This is therefore an animal between the slug and the snail.

Oscana. An oval, coriaceous, almost transparent univalve shell without a spire. The shell of this genus, and of which one

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species only is known, which is found adhering to prawns, is in form similar to the Patellæ, and the animal approaches to that of the Chiton.

Carinaria. A univalve shell, very thin; its form a cone flattened on its sides; its summit rolled spirally and very small; the back covered with a dentated keel; the opening entire, oval, oblong, and contracted towards the angle of the keel. Linnæus had placed this shell, which is exceedingly delicate, and as transparent as glass, among the Patellæ, by the name of Patella cristata; but Dargenville, Martini, and Gmelin, have ranged it under the Argonauts by the name of Argonauta vitrea. Brugulere appears to have been disposed rather to have replaced it among the Patellæ: but Lamarck has thought it right to consider it as a species of a distinct genus.

Haliotis. A flattish ear-formed shell; the spire much sunk; the opening very large; much longer than wide; pierced with holes disposed in a line. No change is proposed in this genus of Linnæus by the French testaceologists.

Sigaretus. An oval, depressed, nearly ear-formed shell, with a short spiral columella; the opening entire, very large, widened near the top of the right lip, and longer than wide. This shell had been placed by Linnæus among the Helices, under the name of Helix haliotoideæ: and by Muller among the Bullæ, under the name of Bulla velutina; but Lamarck seems very probably to have disposed of it under a distinct intermediate genus between the Nerites and the ear-shells.

Stomatia. Is a genus which has been formed by Helblins and Lamarck from a shell, which has been placed under the genus Haliotis, but which wanted the holes which exist in the shells of that genus.

Argonauta. A very thin, single chambered univalve shell: the spire concealed in the internal part of the shell.

Concholepas. An oval univalve, convex in its superior part, with its summit obliquely inclined upon the left edge; the cavity simple; two teeth and a sinus at the base of the right edge. Dargenville and others had placed the shell of this genus among the Patellæ; but Brugulere, having seen several with tendinous opercula, disposed them under the genus Buccinum. Lamarck has, however, thought fit to consider it as forming a genus connecting the Patellæ with the other spire valved shells.

Nerita. A semiglobular univalve, flattish beneath, not umbilicated at the spire, the opening semicircular, the columella or partition nearly transverse. Lamarck has retained in this genus only the imperforated Nerites; the others he transfers to the next genus. The Nerites have not only no umbilicus, but no true columella, having in its place a simple partition, which is flat, thin, and longitudinal, originating in the groove of the first spire, and generally dentated.

Natica. This genus of Lamarck's is characterized by an early globular shell, umbilicated at the left lip, with a callosity at the umbilicus; the opening semicircular; the columella oblique, and not dentated.

Helicina. This genus is founded by Lamarck on a shell figured by Lister (Plate LXXI. fig. 59.) and which he describes as a globular shell; the opening entire, semioval; columella with a callus, compressed inferiorly; and operculum. The propriety of this adoption cannot be judged of from merely the figure of this shell in Lister's work.

Helix. An orbicular or elongated univalve, with an obtuse or concave spire; the opening entire, forming a half moon. Lamarck divides the shells which have been hitherto disposed under this genus into eight genera. 1. Bulimus, an oval or oblong shell, the opening whole, longer than wide; the columella smooth, without folds, truncature or widening, at the base; as in Bulima hæmastoma. 2. Lymnæa, an oblong subturriculated shell, longer than wide; opening entire, the inferior part of the right edge turning up, and passing into the opening, and forming a very oblique fold on the columella; as in Helix stagnalis. 3. Melania, a turriculated shell; the opening entire, oval or oblong, widened at the base of the columella; Helix amarula is of this genus. 4. Ampullaria, a globular berried shell, umbilicated at its base, no callosities on the left lip; the opening entire, longer than wide. Helix ampullacea forms this genus. 5. Planorbis. A discoid shell, the spire flattened or sunk, not prominent, the opening entire, longer than wide, and filled up laterally by the convex projection of the last turn but one. The type of this genus is Helix planorbis. 6. Haliotidea. 7. Ianthina. 8. Helix, a globular shell, with a convex or conoidal spire; and particularly with the opening diminished by the projection of the last turn but one; but as this last character is common to the Planorbis also, these two genera are evidently confounded. The

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separation, which is hereafter made of some shells, which originally were in the genus Helix, in agreement with the ideas of Brugulere, will be, therefore, more correct.

Volvaria, a cylindrical shell, twisted on itself, without a projecting spire; the opening narrow, as long as the shell; one or more folds on the base of the columella. This genus was formed by Lamarck, from a shell which is figured and described by Pennant, vol. iv. Plate LXX fig. 85 He considers it as an intermediate between Bulla and Bulima.

Bulla. A tumid shell, the spire not projecting; the opening as long as the shell; no umbilicus. This genus of Linnæus has been much reduced by Brugulere, who placed several species under Bulima, and established his genus Ovula. Lamarck has still further reduced them, by forming the genera Terebellum, Pyrula, Ampulla, and Achatina.

Ianthina. This genus is formed by Lamarck on a single shell described by Lister, Brown, Forskal, and other naturalists; which derives its claims of distinction from Helix, not so much from the character of the shell as from that of the animal, which differs in its structure materially from the animal of the Helix, since it is furnished with a curious apparatus, being an inhabitant of the sea, for swimming, instead of that for crawling, with which the Helices are provided. It is nearly globular, and almost diaphanous; the opening is nearly triangular, with an angular sinus at the right edge.

Turritella. This genus was formed by Lamarck for the reception of those shells which Linnæus had placed in the last section of his genus Turbo, as Towers; and which Dargenville and Favanne had considered as screws. The characters of the genus are, a turriculated shell; the opening round, whole, but having a sinus at the right edge.

Cyclostoma. This genus was formed by Lamarck for the reception of the Wentletrap, and other shells of the same character. The propriety of thus forming a new genus is rendered evident, by the doubts which had arisen respecting the placing of it in any old genus. Linnæus having considered it a Turbo; Rumphius, a Buccinum; Dargenville, a Screw; and Davila, Gualteri, Guettard, and Favanne, merely a Tube, from its not possessing a columella, which they considered as essential in a univalve shell. The shells of this genus differ in their forms; their openings are nearly round, and their sides connected circularly. The shell is formed of seven spires, separated by a void space; with ten or twelve longitudinal ribs, which, uniting, form a rim round the lip These ribs externally supply the place of a columella.

Bulimus. A globular. oval, or turriculated shell, the opening of which is entire, not grooved at the base, and always longer than wide This genus of Brugulere comprises some of the shells considered by Linnæus as Helices and Bullæ; and the genera Auricula, Pyramidella, Melania, Lymnæa, Agathina, Maillot, and Bulima, of Lamarck. The essential character distinguishing this genus from Helix is the opening being longer than it is wide.

Turbo. A conoidal or turriculated shell; the opening entire, round, without any tooth; the edges disjoined on the superior part. Several shells, which were reckoned by Linnæus of this genus, have been removed from it by Brugulere, and placed under his genus Bulima, and others have been taken from it by Lamarck, and disposed under the genera Cyclostoma and Turritella.

Trochus. A conical univalve shell: the opening almost always quadrangular flattened transversely; the columella oblique. Lamarck has divided this genus into four: 1. Trochus. 2. Solarium, with an open umbilicus, or crenulated opening on the inside of the spiral turnings, as in the Trochus perspectivus. 3. Monodenta. The opening rounded, and furnished with a tooth, formed by the truncated and projecting base of the columella, as in Trochus labio, Linnæus. 4. Pyramidella: the columella projecting, perforated at its base, and possessing three transverse folds, as in Trochus dolabratus, Linnæus.

Cerithium. A univalve turriculated shell, the opening terminated at its base by a short, narrow canal, either suddenly turning backwards or truncated, but never grooved out. In this genus of Brugulere are comprehended several shells from the genera Trochus, Strombus, and Murex of Linnæus. The shells differ from those of the Murex by their turriculated form; and from the screws, in not having the groove at the base of the canal.

Pyrula. A subpyriform shell, canaliculated at its base; without any projections, and having the belly part nearer

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to its summit than to its base; the spire short; the columella smooth; the right edge without a groove Lamarck, founding the distinction on the situation of the bellied part of the shell, and on the greater or less length of the spire, has formed two new genera; one with those shells possessing this character of the genus Bulla, and the other of the genus Murex, calling the former Pyrula, and the latter Fusus.

Murex An oval or elongated univalve shell, generally foliated, plaited, spinous, or tuberculated; the opening always prolonged into a canal, running straight, or turning directly backwards, and always entire. In the earlier stages of their growth it is difficult to separate the Murices from the Strombi. Lamarck divides this genus of Linnæus into five genera. 1. Murex, with tuberculated or spinous projections, and channelled at the base, as M. ramosus. 2. Fusus; fusiform, without projections, with the bellied part either equally distant from the extremities or nearest to the base; spire elongated; columella smooth; right edge without groove, as M. colus. 3. Fasciolaria; nearly fusiform; no projections; with two or three very oblique folds on the columella: and channelled at the base, as in M. tulipa. 4. Pleurotoma: fusiform or turriculated, without projections, and having a groove, or sinus, near the summit of the right edge, as in M. babylonicus. 5 Cerithium, already described.

Rostellaria. Lamarck has formed this genus on Strombus fusus (Linnæus,) and on some fossil species found at Courtagnon. The characters of the genus are: a fusiform shell, terminating inferiorly by a canal with a pointed beak; the right edge entire or dentated; dilated more or less in a wing, according to age, and having a sinus contiguous to the canal.

Strombus. A bellied univalve, terminating, at its base, by a canal, accompanied with a distinct sinus; the right lip dilating, or spreading itself out, with age, in a simple or digitated lobe Lamarck divides the genus Strombus of Linnæus into three. 1. Strombus; terminating in a short canal, truncated or grooved out; the right edge dilating, with age, into a simple entire wing or lobe; with a sinus distinct from the groove at the base, as in S. pugilis. 2. Pterocera; a bellied shell, terminated inferiorly by an elongated canal; the right edge dilating, with age, into a digitated wing, and having a sinus near its base, as in S. lambus. 3. Rostellaria, the genus last described.

Buccinum. An oblong or oval shell, the opening of which is terminated at the base by an oblique groove, without any sensible canal, or external border. Brugulere has divided the Buccina of Linnæus into the genera Buccinum, Terebra, Cassidæa, and Purpura. Under the genus Buccinum are therefore here comprised tumid shells, with from three to ten spiral turns; a summit generally flattish; a surface rarely even; the predominating colours dull; the lip extended more or less in a bow, and rarely jagged.

Cassidæa. A tumid shell, the opening longer than wide, terminated at its base by a short canal, recurved towards the back of the shell; the columella plaited in the lower part. This genus of Brugulere is intended to comprise the helmets (casques) of Gualteri, Klein, and others.

Terebra. A turriculated univalve; the opening grooved in the lower part: the base of the columella twisted or oblique.

Purpura An oval shell, generally with spines, or tuberculated; the opening terminating in a very short canal, the extremity of the canal grooved out, the base of the columella finishing in a point. The shells included in this genus by Brugulere are not those species which have been hitherto considered as Purpuræ, by Dargenville and others, and which belong to the genus Murex; but those species which appear to connect the genus Buccinum and Murex. The opening of these shells is rather large, oval, round, upwards, and more contracted in the inferior part: the right lip has but little thickness, and is grooved or notched; the left expands with a wrinkled ridge, which terminates in the groove.

Voluta. A cylindrical, or oval, univalve shell, grooved out at the base, but without a gutter; the opening longer than wide; and the columella plaited. The division of this genus by Linnæus is very clear and useful; but Lamarck proposes a still nicer distinction of the shells of this genus, by dividing them into eight genera. 1. Voluta, an oval shell, more or less bellied, summit obtuse or mammillated; the base grooved, but without a gutter; the columella with several plaits, of which the lowest are largest and longest; as in voluta musica 2. Oliva, sub cylindrical, grooved at the base; the turns of the spire separated by a channel; the columella striated obliquely, as in Voluta oliva. 3. Ancilla, oblong, a short

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spire, base of the opening hardly grooved; a swelling, or oblique roll, at the base of the columella. 4. Mitra, fusiform or turriculated, spire pointed at the summit, the base grooved out, without a gutter; the columella with plaits, the lowest being the least, as in Voluta episcopalis. 5. Columbella, marked by a swelling on the internal face of the right edge, as in Voluta mercatoria. 6. Marginella, the right edge emarginated, as in Voluta vespertilio. 7. Cancellaria, the right edge grooved internally; and the base of the opening almost entire, as in Voluta reticulata. 8. Turbinella, sub-turbinated, canaliculated at its base, with transverse plaits on the columella

Ovula. A tumid shell, more or less elongated at the extremities; the edges rolled inwards; the opening longitudinal, not dentated on the left side. This genus is formed by Lamarck from shells, which had been comprised by Linnæus in his genus Bulla. The shells of the genus Ovula differ from those of Cypræa, chiefly by the absence of teeth from the left side. Bulla volva, ovum, spelta, verrucosa, and gibbosa, of Linnæus, are placed under this genus.

Terebellum, a shell nearly cylindrical, pointed at the summit; the opening longitudinal, narrow upwards, and hollowed out at its base; the columella truncated. This genus is formed, by Lamarck, of the Bulla terebellum of Linnæus, which he has removed from the genus Bulla, and has placed in this genus, as intermediate between the Ovulæ and the Olives.

Cypræa. A convex, univalve shell, the edges turned inwards: the opening long and narrow, and toothed on each side. The shells of this genus are so distinctly characterized, as to have escaped that confusion which has taken place in many other genera.

Conus. A conical, convoluted univalve; the opening of the length of the shell; linear, without teeth, and hollowed out at the top; the columella smooth. The generic characters are here so determinate, as not to have left any opportunity for changing the acceptation of this genus, as established by Linnæus.

Vermicularia. A tubular shell, twisted in an irregular spiral, in general adhering to some body, and furnished with an operculated opening. The shells with which Lamarck has formed this genus were blended by Linnæus with the Serpulæ; but the animals which inhabit these shells are very different from the Terebrellæ, which are the only inhabitants of the true Serpulæ.

Silicaria. A tubular shell, spirally convoluted, and laterally divided through its whole length by a narrow fissure; the mouth roundish. Linnæus himself considers it as doubtful whether the shell which forms this genus (Serpula anguina) should be placed under the genus Serpula, or not; but Brugulere, Lamarck, and Daudin, have thought it necessary to establish for it this new genus.

Penicellus. A long tubular conical shell, the superior extremity closed by a disk, beset with numerous short tubes, and surrounded by a projecting coronet; the inferior extremity having been fixed to some solid body. Linnæus had doubted whether the shell, of which Brugulere has formed this genus, ought not to be placed under the genus Teredo, rather than under that of Serpula, where, however, he left it.

Nautilus. A spiral and nearly discoidal shell, the last turn of which envelopes the rest, and the sides of which are smooth: numerous chambers, formed by transverse smooth septa, perforated by a tube. This genus is divided by Lamarck into three. 1. Nautilus, 2. Spirula, 3. Orthocera.

Orbulites. A spiral, and nearly discoidal shell, the last spire enveloping the rest; the sides articulated by winding sutures; the transverse septæ being pierced by a marginal tube. The shells which Lamarck has assumed for this genus have been hitherto confounded with the Ammonites; they are only known as fossils and as casts.

Ammonites. A discoidal spiral shell, the turns contiguous and all visible, the sides articulated by foliated sutures, and the transverse septæ terminating in winding processes, and pierced by a marginal tube. These, like the shells of the preceding genus, are only with certainty known to exist as fossils.

Planulites. A discoidal spiral shell, with contiguous and visible turns, with smooth sides, and transverse septæ, not foliated. These shells are supposed to bear the same relationship to the Ammonites as the Nautili do to the Ammonites; but the difference between them and the Ammonites is so little as must often be with difficulty discoverable.

Camerina. A shell with a single valve, without any external spire, the internal part divided into numerous chambers by imperforated septa. This genus was formed by Brugulere, for the reception of the fossil shells long known as Lapides lenticulares and Nummulites.

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Rotalites. A depressed orbicular, discoidal chambered shell, smooth on the upper, radiated on the under side, with tubercular and unequal points in the centre; the edge carinated, and having a small trigonal marginal opening. The fossil shell on which this genus was formed is figured and described by Guettard in his Memoirs on Fossils.

Turrilites. A spiral turbinated shell, with contiguous and visible turns, the sides articulated by winding sutures; transverse pierced septa, with foliated terminations; the opening round. The shells belonging to this genus are all fossil, and even the fragments of their casts are very rare. The characters of the shells of this genus are very striking, their internal structure being similar to that of the Ammonites, while they possess a turriculated or wreathed form.

Baculites. A straight cylindrical and rather conical shell; the sides articulated by winding sutures; the transverse septa terminating in foliaceous forms. This genus is founded on a fossil shell, described by Faujas St. Fond in his Natural History of St. Peter's Mountain, near Maestrecht, and which he considers as a straight Ammonite.

Spirula. A shell partially or completely in a discoidal spire; the turns separate, and the last extending into a straight line; transverse smooth septa, pierced by a tube; the opening round. This genus comprises also the Lituites, a fossil shell, bearing a very close resemblance, in form, to the recent shells of this genus, but very far exceeding them in size.

Belemnites, a many chambered, straight, long, conical pointed shell, full at its summit, and possessing a lateral cleft.—These are only known in a mineral state.

Shell, in chemistry. Shells of marine animals, and of all eggs, consist chiefly of carbonate of lime, and yield a very pure lime, for which they are used on the seacoast. They afford, likewise, a small portion of phosphate of lime. There are two great classes of marine shells, the testaceous and crustaceous, the former are by much the most numerous, and include all the marine shell animals that have not legs, and the power of transporting themselves from place to place. The crustaceous shells are those of the lobster, crab, prawn, &c. who carry their shell as a protection from external injury, and not as a place of residence. Mr. Hatchet has made many experiments on shells, and he observes that marine shells, for the most part, are either of a porcellaneous aspect, with an enamelled surface and fibrous texture, or they are composed of the substance called nacre, or mother of pearl. The first kind dissolved in acids with strong effervescence, and their solutions afforded no trace of the phosphate of lime: they contained only carbonate of lime, and the animal matter, which acts as a cement to this, and which he supposes to be albumen in various states of induration; this is in small proportion; hence shells exposed to heat exhale but little empyreumatic animal odour; they emit no smoke, and when dissolved in acids no vestige of it could be discovered. In shells of the other description approaching to nacre, the earthy matter is carbonate of lime, but in a smaller proportion, while the animal matter is in considerable quantity. These give out smoke and an empyreumatic odour, when exposed to heat; and when acted upon by acids, give out less carbonic acid gas, and leave a large quantity of a membranaceous or cartilaginous residuum. This substance often constitutes a large part of the shell, as in that of the oyster or muscle, and is so much indurated as to be no longer gelatinous; and in all shells of this division it appears to be deposited in layers, each having a corresponding coat of carbonate of lime.

Shells, in gunnery, are hollow iron balls to throw out of mortars or howitzers, with a fuze-hole of about an inch diameter, to load them with powder, and to receive the fuze: the bottom, or part opposite the fuze, is made heavier than the rest, that the fuze may fall uppermost; but in small elevations this is not always the case, nor is it necessary; for let it fall as it will, the fuze sets fire to the powder within, which bursts the shell, and causes great devastation. The shells had much better be made of an equal thickness, for then they burst into more pieces.

Shells, *message*, are nothing more than howitz shells, in the inside of which a letter, or other papers are put. The fuze-hole is stopped up with wood or cork, and the shells are fired out of a royal or howitz, either into a garrison or camp. It is supposed that the person to whom the letter is sent, knows the time, and accordingly appoints a guard to look out for its arrival.

"To find the weight of a shell." Rule. Double the difference of diameters of the shell and hollow sphere, and seven times the result gives the weight in pounds, cutting off the two right hand figures of whole numbers. Ex. Let the diameter

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of the shell be 13 inches, and that of the hollow sphere 9.5. Then the cube of 13 is 2197, and that of 9.5 is 857 357; the difference is 1339.625, its double is 2679.25, which, multiplied by 7, gives 18754.625; and cutting off two places in whole numbers, the result is 187 *lb.* or 1 *cwt.* 2 *qrs.* 21 *lb.*, the weight of the shell.

Shell, a particular part of a sword, which serves as a shield to the hand when it grasps the hilt. The regulation sword, which is directed to be worn in a cross belt, has its shell so constructed, that one side can fall down, by which means the hilt hangs more conveniently.

Shell, a short jacket without arms, which was worn by light dragoons, and in some instances by the infantry, before the new regulations took place respecting the clothing of the British army. At the commencement of the present war, some militia colonels derived no inconsiderable emolument from this mode of dress

SHELVES, in naval affairs, a general name given to any dangerous shallows, sand-banks, or rocks, lying immediately under the surface of of the water.

SHERARDIA, in botany, so named in honour of William Sherard, L. L. D. consul at Smyrna, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: corolla one-petalled, funnel-form, superior; seeds two, three toothed. There are three species.

SHERIFF. As keeper of the King's peace, the sheriff is the first man in the county, and superior in rank to any nobleman therein, during his office. He may apprehend and commit to prison all persons who break the peace, or attempt to break it, and may bind any one in a recognisance to keep the King's peace. He may, and is bound, *ex officio*, to pursue and take all traitors, murderers, felons, and other misdoers, and commit them to gaol for safe custody. He is also to defend his country against any of the King's enemies, when they come into the land; and for this purpose, as well as for keeping the peace and pursuing felons, he may command all the people of his county to attend him, which is called the *posse comitatus*, or power of the county; which summons every person above fifteen years of age, and under the degree of a peer, is bound to attend, upon warning, on pain of fine and imprisonment. Yet he cannot exercise the office of a justice of the peace; for then this inconvenience would arise, that he should command himself to execute his own precepts.

The sheriff has a jurisdiction both in criminal and civil cases, and therefore he has two courts: his town court for criminal causes, which is the King's court; the other in his county court, for civil causes, and this is the court of the sheriff himself. When the new sheriff is appointed and sworn, he ought, at or before the next county court, to deliver a writ of discharge to the old sheriff, who is to set over all the prisoners in the gaol, severally by their names, (together with all the writs,) precisely, by view and indenture between the two sheriffs; wherein must be comprehended all the actions which the old sheriff has against every prisoner, though the executions are of record; and till the delivery of the prisoners to the new sheriff, they remain in the custody of the old sheriff, notwithstanding the letters patent of appointment, the writ of discharge, and the writ of delivery. Neither is the new sheriff obliged to receive the prisoners, but at the gaol; but the office of the old sheriff ceases when the writ of discharge is brought to him.

By 3 George I. c. 15, it shall not be lawful for any person to buy, sell, let, or take to farm, the office of under sheriff, or deputy sheriff, or seal keeper, county clerk, shire clerk, gaoler, bailiff, or any other office pertaining to the office of high sheriff, or to contract for any of the said offices, on forfeiture of 500*l.*; one moiety to his Majesty, the other to such as shall sue in any court of Westminster, within two years after the offence.

Provided that nothing in this act shall prevent any high sheriff from constituting an under sheriff, or deputy sheriff, as by law he may; nor to hinder the under sheriff, in any case of the high sheriff's death, when he acts as high sheriff, from constituting a deputy; nor to hinder such sheriff, or under sheriff, from receiving the lawful perquisites of his office, or for taking security for the due answering the same; nor to hinder such sheriff or under sheriff, deputy sheriff, seal keeper, &c. from accounting to the high sheriff for all such lawful fees as shall be by them taken, nor for giving security so to do; or to hinder the high sheriff from allowing a salary to his under sheriff, &c. or other officers And if any sheriff shall die before the expiration of his year, or before he be superseded, the under sheriff shall nevertheless continue in his office, and execute the same in the name of the de-

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ceased, till another sheriff be appointed and sworn: and the under sheriff shall be answerable for the execution of the office during such interval, as the high sheriff would have been; and the security given by the under sheriff and his pledges shall stand a security to the King, and all persons whatsoever, for the performing his office during such interval.

There is no particular qualification in lands required for the office of sheriff, but a sheriff cannot be elected to serve in parliament for the county of which he is sheriff. The under sheriff performs nearly all the duties of the sheriff. He is not to hold his office above one year, under the penalty of 200*l*. And no under sheriff or bailiff shall practise as an attorney; but this is so openly evaded, that no person is appointed under sheriff except an attorney.

SHIELD, an ancient weapon of defence, in the form of a light buckler, borne on the arm, to turn off lances, darts, &c.

SHIELD, in heraldry, the escutcheon or field on which the bearings of coats of arms are placed.

SHILLING, an English silver coin equal to 12 pence, or the 20th part of a pound sterling. This was a Saxon coin, being the 48th part of their pound weight. Its value at first was 5 pence; but it was reduced to 4 pence about a century before the conquest. After the conquest, the French solidus, of 12 pence, which was in use among the Normans, was called by the English name of shilling; and the Saxon shilling of four pence took a Norman name, and was called the groat or great coin, because it was the largest English coin then known in England. From this time the shilling underwent many alterations. In the time of Edward I. the pound troy was the same as the pound sterling of silver, consisting of 20 shillings; so that the shilling weighed the 20th part of a pound, or more than half an ounce troy. But some are of opinion there were no coins of this denomination, till Henry VII. in the year 1504, first coined silver piece of 12 pence value, which we call shillings. Since the reign of Elizabeth, a shilling weighs the 62d part of a pound troy, or 3 *dwts.* $20\frac{8}{31}$ *grs.* the pound weight of silver making 62 shillings. And hence the ounce of silver is worth 5*s.* 2*d.* or $5\frac{1}{6}$ shillings.

SHINGLES, in building, are generally made of cedar, cypress, and oak stuff, from one to three feet long, split into lengths from three to seven inches wide, and shaved into the shape of a wedge, three quarters of an inch thick at the butt. Shingles are used as a covering to the roofs of houses, steeples, &c.; laid and nailed on oak lath, beginning at the eaves, ascending the rafters, and lapping one another in successive courses, from five to seven inches deep.

SHIP *building*. The man of science and the practical shipwright have long lamented, that in the theory of the art of ship-building there are so few fixed and positive principles established by demonstration, or confirmed by practice; thus the artist, being left to the exercise of his own opinion, in general resists theoretical propositions, however speciously founded, so hard has it ever been found to overcome habitual prejudices.

The great neglect of the theory of ship-building is much to be deplored in a country like this, where the practical part is so well understood and executed. Mathematics, engineering, and civil or house architect, are sciences nourished and taught in our universities and other schools, and however superior scholars may arrive in those arts, and celebrated for their abilities, show them shipping draughts, or talk to them of the science of ship-building, and they appear as much at a loss as though they had never heard of such an art; nevertheless, it may be but justice to add, that some men of different professions have felt themselves interested in its progress to perfection, and lately we have seen the endeavours of men conversant in the practical parts of ship-building, publishing their ideas, and this in hopes that gentlemen of more scientific abilities may be induced to add to their labours, and make the theory of ship-building much more familiar in this country, as few, very few, professional shipwrights have hitherto had it in their power to employ their talents to improve this science by theory.

Ships are bodies, which, when to be put in motion, have water for their resisting force, and a contrary element, as air or wind for their impelling force: therefore the theorist and practical ship-builder should ever keep particularly in view to improve himself in the knowledge of floating bodies, and endeavour to gain a complete knowledge of the resistance of fluids; add to this aerostatics and mathematics in general. Thus taught, the man of practice would, though cautiously, add the speculation of the theorist, as there is a great deal to be risked, and much to be suffered; but could the ideas of the theorist and the man of practice be assi-

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milated and well weighed together, much benefit to the art of ship-building might be acquired, and their most useful ideas be reduced to the test of experiment.

When experience favours theory, then we arrive at the desired point; but the difficulty and expense of accurately making a sufficient number of experiments is a great hindrance to its assumption, and has greatly hindered that desired knowledge in this branch of science. Notwithstanding these obstacles, many opportunities offer of introducing well digested theory, though cautiously and by degrees, into the many various ships and vessels building in this kingdom; and thus we would hope, by the united efforts of the theorist, ship-builder, and mariner, who should carefully notice and report every observation in his power of the vessel acting in her various situations, that the different results being accurately stated, desirable data may be reasonably established.

It is well known that bodies of any magnitude could not be built or put together without designs or drawings on convenient scales, particularly that complex machine a ship; therefore an accurate delineation of the whole vessel, with respect to its various lengths, heights, breadths, and depths, is carefully represented by a drawing, called the sheer draught, the construction of which, with its several lines, &c. we shall endeavour as familiarly as possible to describe to our readers.

The principal dimensions as they are generally termed, must be first decided upon, and they are the following, *viz.*

The length at the gun-deck in ships of war, or distance between the extreme perpendiculars in merchant ships.

The extreme breadth, which is the thickness of the bottom plank on each side, added to the moulded breadth, or broadest part of the ship in midships.

Length of the keel for tonnage, which results from the extreme breadth, and a length hereafter given.

Depth in hold, which must be always regulated by the properties required of the vessel.

Burthen in tons, resulting from the extreme breadth and length of the keel for tonnage, being multiplied into each other by a rule given hereafter.

Now these are called the principal dimensions, which we will endeavour to describe, with their concomitant circumstances, in their above order; and, first, the length on the gun-deck; this in ships of war must ever contain sufficient distance between the perpendiculars for all the ports, and room between each port for working the guns, and what may be required at the extremities, such as the manger at the fore-part and abaft, room for the after-port to come clear of the wing transom knee, &c. It will also appear evident, that the distance between each port in the clear must contain space sufficient for two frame timbers and the filling timbers between, and the room or openings between the timbers. Thus we find by established practice the distance between, and size of, the ports, in the following class of ships in the navy, are as follow:

	Guns.										Sloop.	
On the main deck, *viz.* - -	110		98		74		50		36		18	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Foreside of the foremost port abaft the foremost perpendicular - - - - -	11	6	11	4	7	0	17	6	10	6	6	9
Aft-side of the after port, afore the after perpendicular -	13	0	15	6	16	6	13	0	4	9	12	0
Ports - - - deep	2	9	2	9	2	8	2	7	2	6	2	2
fore and aft	3	5	3	5	3	5	3	4	3	0	2	5
In distance from port to port*	7	9	7	9	7	6	7	10	7	0	6	11
In number on each side - -	16		15		15		11		13		10	
Thus we may find the most approved length on the gun deck - - - - - -	193	0	188	8	180	0	146	0	137	0	110	0

* Sometimes an additional timber is added between the ports at the gangway, to make it the more convenient for the steps, &c.

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	Tonnage of Merchant Ships.					
	1257	1000	818	544	441	329
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
Foreside of the foremost port abaft the foremost perpendicular - - - - - - -	22 6	22 0	22 0	14 6	31 0	6 6
Aft-side of the after port afore the after perpendicular -	14 6	13 6	13 4	12 6	Foreside well.	8 4
Ports - - - - - - deep	2 2	2 2	2 2	2 0	2 0	1 10
fore and aft	2 5	2 5	2 5	2 4	2 4	2 3
In distance from port to port*	8 3	8 3	8 3	7 6	6 0	7 6
In number on each side - -	13	12	12	11	10	10
Thus we may find the most approved length between the perpendiculars of merchant ships - - - - -	165 6	159	146 0	124 9	120 9	103 4

The next dimension is the extreme breadth, and without repeating the proportions which various authors have mentioned, all alike erroneous as to fixed data, we will give the extreme breadths of the above ships, which upon trial have been found to answer their intended purposes by that construction.

	Guns.					Sloop.
	110	98	74	50	36	18
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
Breadth, moulded - - - -	52 0	49 0	48 0	39 10	37 6	29 0
Breadth, extreme - - - -	52 10	49 10	48 8	40 6	38 2	29 6

	Tonnage of Merchant Ships.					
	1257	1000	818	544	441	329
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
Breadth, moulded - - - -	41 2	37 4	35 4	31 4	28 6	27 0
Breadth, extreme - - - -	42 0	38 0	36 0	32 0	29 0	27 6

The length of the keel for tonnage, as was before observed, is produced from the former dimension, and a length given by a rule, although long established, is very defective, and the tonnage or burthen of the vessel, as it is sometimes called, is said to be produced therefrom. It may be therefore readily seen, that those two dimensions only cannot possibly give any true burthen, for those two dimensions may be alike in two vessels, of the greatest difference in their construction imaginable, for one vessel may be so constructed from the same dimensions, as to be very sharp under her load draught of water, with a very quick rising, to possess the requisite qualities for fast sailing, as the sloop of war; while another vessel keeping the dimensions the same, may be constructed as full under water as the most burthensome merchant ships. Sometimes the production of this rule is called builder's tonnage, as a contradistinction to the true tonnage, and by this result builders are paid a certain price per ton for building any vessel.

THE RULE FOR CASTING THE TONNAGE,

In the royal navy, is to take the length

* Sometimes an additional timber is added between the ports at the gang-way, to make it the more convenient for the steps, &c.

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on a straight line along the lower side of the rabbit of the keel, from a perpendicular or square from the back of the main stern post, at the height of the wing-transom, to a perpendicular or square at the height of the upper deck (and middle deck of three decked ships) from the fore-part of the stern. The only difference in merchant ships is to take this length as before, from the back of the main-post, at the height of the wing-transom, to the same height forward to the foreside of the stern; then from the length between those perpendiculars subtract three-fifths of the extreme breadth for the rake forward, and two inches and a half for every foot the wing-transom is high above the lower part of the rabbit of the keel for the rake abaft. The remainder is the length of the keel for tonnage.

Although this is the dimension sought, yet, to show the fallacy of acquiring this tonnage, the whole of the rule shall be here subjoined.

Then multiply the length of the keel for tonnage by the extreme breadth, and the product by half that breadth, and divide the whole by 94; the quotient will be the tonnage.

This extreme breadth to be taken from the outside to the outside plank or thickstuff, in the broadest part of the ship, either above, on, or below the wales, deducting from the said thickstuff or plank all that it exceeds the thickness of the plank of the bottom, which shall be accounted the extreme breadth; so that the moulding breadth, or breadth of the frame, will then be less than the extreme breadth so found. For the thickness of the bottom plank, see the foregoing dimensions.

By this rule, the following lengths of the keel for tonnage of the same class of ships are found, of

Guns.	Ft.	In.	Tons.	Ft.	In.
110 . . .	158	10	1257 . . .	134	0
98 . . .	156	6	1000 . . .	131	0
74 . . .	148	8½	818 . . .	118	8
50 . . .	119	9	544 . . .	100	0
36 . . .	113	3	441 . . .	98	8
18 . . .	90	8	329 . . .	82	0

Also their burthen in tons;

Guns.	Tons.	Guns.	Tons.
110	2358	50	1044
98	2067	36	877
74	1873	18	419

	Tons.
East India ships . .	1257
Ditto	1000
Ditto	818
West India ships . .	544
Ditto	441
Ditto	329

Hence it is obvious, had the length and breadth of the ships in the royal navy, and those in the merchant-service, been the same, the tonnage would also have been the same, although the construction under water is so very different; therefore no dependence can be placed on those rules for the conformation of the real burthen of vessels. And as to builder's tonnage, it is equally as fallacious, because depth is not taken at all into consideration, and it is easy to imagine that two vessels may, by this rule, be the same tonnage, and one some feet deeper than the other; consequently, what results to the builder is, to regulate his price accordingly. Hence, there remains scarcely one undeviating method in the construction of ships. We will allow, it is not to be expected to obtain any rule, in this particular, that would be quite exact; because the true burthen, or tonnage, a ship should carry, not only depends upon the cubical dimensions of the ship's bottom, but her own gravity with respect to the whole of the hull; and, in short, on the weight of every article which makes a part of the ship. Therefore, the nearest rule that approximates to the burthen different built vessels are found by experience to carry, should be adopted; as the fallacy of the rule in present use discovers no one thing whatever, as may be easily seen by any person, though a novice in the art of ship-building.

Lastly, the depth in hold, which, in naval ships, must be always governed by the height which the guns are intended to be above the water, and load-water line; as the depth is taken from the upper side of the limber-strake to the upper side of the lower deck beam in midships. In merchant vessels, the depth in hold is regulated for the different cargoes that each may be designed to carry; and here, again, as there can be no certain rule observed, we will give the depth in hold of the same acknowledged superior vessels.

Guns.	Ft.	In.	Tons.	Ft.	In.
110 . . .	22	9	1200 . . .	17	0
98 . . .	21	0	1000 . . .	14	9
74 . . .	19	6	800 . . .	14	9

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Guns.	Ft.	In.	Tons.	Ft.	In.
50	17	6	544	14	9
36	13	4	440	12	2
18	1	6	330	12	0

To these dimensions we shall add the load-draught of water of the same ships.

	Guns.	Ft.	I.	Guns.	Ft.	I.	Guns.	Ft.	I.	Guns.	Ft.	I.	Guns.	Ft.	I.	Guns.	Ft.	I.
Afore	110	23	0	98	22	[illegible]	74	20	[illegible]	50	18	[illegible]	36	18	0	18	13	0
Abaft		24	0		23	0		20	6		18	9		20	[illegible]		14	6
	Tons.			Tons.			Tons.			Tons.			Tons.			Tons.		
Afore	1257	23	9	1000	21	0	818	20	0	544	17	6	440	16	0	330	14	3
Abaft		23	9		21	0		20	0		17	6		16	0		14	3

Thus, having gained a few of the first leading principles, we will proceed to show their utility in constructing what is called the sheer-draught: and the necessity of dividing the sheer-draught into three distinct plans will be evident by inspection.

First. The sheer-plan, called, in general architecture, the plan of elevation. This is a section of the ship made by a vertical or perpendicular plane, passing through the middle line of the keel, stem, and stern-post, throughout the whole length of the ship.

Secondly. The half-breadth plan, called by architects the ground-plan. This plan consists of an horizontal view of the half-breadths of the water-lines, ribbands, main and top-breadths, half-breadth of the rising, ditto by longitudinal curves, by which the several breadths are limited, and, as they would appear to the eye, placed directly over, and looking down on the aforesaid sections, whether cutting the solid (supposing a ship a solid body) either by horizontal, diagonal, or sheer planes.

Thirdly. The body-plan, or plan of projection, are the transverse sections of the ship, at the joint of every frame-timber, showing the half breadth of each frame-timber, as it stands perpendicularly to the two former plans: hence, the frames contained between ⊕, or the midship, that being the broadest frame, and the stem, are represented on the right-hand side, and the frames at aft ⊕ on the left hand of the middle line in the body-plan are respectively called the fore and after body.

It may be necessary to add, that in all these plans only one half of the ship is represented, as each side must be supposed to be exactly alike, and that they must be very accurately drawn to the dimensions given, which have all been examined by proper calculations, submitted to the most precise scrutiny, and the results have actually stood the best test, that is, experiment; the said ship having been really built, and found to answer every expectation. Now, in the clearest manner possible, we will endeavour to point out the utility of these plans, in the construction of the various curves that form the body of a ship in their different points of view, whether transverse or longitudinally, as on the several plans they will present themselves in very different directions; for, although the horizontal water-lines are represented by curves in the half-breadth plan, they are straight lines in sheer and body plan, and so likewise the appearance of the timbers; for, although they present themselves as vertical curves in the body plan, they appear as straight lines in the sheer and half-breadth plan; these premises being well understood, we may proceed to the construction of these several plans; and first, in the

Sheer plan, draw the stem keel, stern-post, &c. thus: draw a straight line that shall represent the upper edge of the rabbit of the keel, more than the main half-breadth of the vessel above the lower edge of the paper; then to your right-hand square up the foremost perpendicular, allowing room to represent the head. Now, as the limits of our design will not admit of our continuing the dimensions of all the before mentioned ships; and as only one can be selected to form the sheer draught, the 74 gun ship is made choice of, as being, of all vessels, the most handsome, and arrived to the greatest perfection in the construction; therefore set aft 180 feet from the foremost perpendicular, and square up another, calling it the after perpendicular, which gives the length of the gun-deck, or first principal dimension. Then square up another perpendicular, 69.0 feet abaft the foremost one, which is the midship perpendicular marked thus ⊕, and called dead flat. Much has been said concerning the situation of this transverse section, it being the broadest part of the ship, and containing the greatest

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area of surface; its judicious disposal will certainly facilitate the velocity of the vessel. All have agreed, and experience has confirmed it, that its position should always be before the middle of the vessel's length, or its centre of gravity. The French say, about $\frac{7}{12}$ the length of the vessel from aft, and nearly there may be its best position, as vessels, in general, have been found much better constructed since the midship has been fixed nearer the stern.

Set up from the upper edge of the keel, or rabbit, the height of the under side of the gun-deck, at the middle line, or middle of the ship, which is 24 feet 5 inches at the foremost perpendicular, 22 feet at ⊕, and 25 feet 4 inches up the after perpendicular; having these three heights, the hang, or sheer of the deck, may be obtained, all fore and aft, by a drawing-bow, the lath of which is pressed by its screws, until it intersects the said heights set up, as this is supposed to produce the arch of a circle equal to the sheer of the deck; the upper side of the deck is then shown, by a line drawn 4 inches above, and parallel to its under side. Then, when the under side of the gun-deck intersects the foremost perpendicular, set forward 4 inches for the rabbit of the stem, and 7 inches afore the rabbit, for the fore-side of the stem, and 7 inches abaft the aft-side of the rabbit, for the aft-side of the stem, the whole making 18 inches, the moulding of the stem; then with a radius equal to 24 feet, half the moulded breadth, sweep an arch which will form the aft-side of the stem below the gun-deck, intersecting the line drawn for the upper edge of the rabbit of the keel; then lengthen the radius to the fore-side of the stem, and sweep a circle parallel to the aft-side; then sweep in the aft-side of the rabbit, by the radius 24 feet, keeping the centre the same height above the upper edge of the rabbit on the keel; as there the aft-side of the rabbit on the stem at the gun-deck, and the rabbit of the keel, intersect each other, by carrying the centre 7 inches before the first; then describe the aft-side of the rabbit, and by opening the radius 4 inches more, the fore-side of the rabbit will be parallel to the aft-side, and the stem and rabbit shown below the lower-deck, except the boxing, or keel, which will be determined on hereafter; then set up from the upper edge of the rabbit of the keel, on the foremost perpendicular, 36 feet, the height of the upper part of the stern, and draw a horizontal line upon this line before the perpendicular; set off 15 inches, which is what the stem rakes forward at the head; thence draw a straight line, or one a little curving, to break in fair with the back of the foremost sweep, at gun-decks, and the fore-side of the stem is complete; then draw another, 18 inches from, and parallel to, the fore-side, and the aft-side will be drawn; then by the same curve the rabbit may be continued up on the fore-side, to the head of the stem, as the aft-side of the rabbit may not be drawn higher than the under side of the wall.

Proceed to draw in the stern-post thus: before the after perpendicular on the upper edge of the keel, set 7 inches; then set up the after perpendicular 27 feet from the upper edge of the keel, and draw a horizontal line, which is the upper side of the wing transom on that line abaft the perpendicular, set off 23 inches; then a straight line drawn through those two spots will represent the aft-side of the stern-post; then from the aft-side of the stern-post, set forward on the upper side of the keel 2 feet 1 inch, and at the upper side of the wing transom 13 inches; a straight line drawn through these two spots will be the aft-side of the rabbit, and another line 4 inches parallel before it, will be the fore-side of the rabbit, which will intersect the perpendicular at the gun-deck. The stern-post, thus far described, would be sufficient at present; but to complete it, set up 2 feet 8 inches above the upper side of the wing transom, and continue upwards the aft-side; then, on a line parallel to the under side of the deck, at that height set forward 20 inches, and from the aft-side 3 feet upon the upper side of the keel, a line, drawn through those spots and the stern-post, will be represented from the head downwards. Draw another line before the fore-side of the post, on the keel, 16 inches, and at the under side of the deck transom 13 inches, and the fore-side of the inner post will be likewise represented. Thus we have the extremities of the ship below the main-breadth.

The height of breadth-lines are next to be drawn on the sheer plan, and there they determine the height of the broadest part of the ship, at each transverse section or timber; that nearest the keel is called the lower height of breadth, and the one above the upper height of breadth. The lower height of breadth in the midships generally is placed midway between the ports and the load-water line in naval ships, and rather above the load-water line in merchant-ships; its quick rise forward and aft is highly requisite for

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preserving a greater breadth above the load-water line, to assist and relieve the ship in her pitching and rolling motions in a heavy sea, lifting her forward, and making her lively, as the seamen call it. In order to set up the height of breadth-lines, it is necessary that the stations of several of the timbers should be set off between the perpendicular at ⊕, and the stem forward, and the stern-post abaft: here the timber and room, or room and space, must be determined, which is the diameter between the moulding edges, or joints of every two timbers, and an interval of two or more inches between them; for here it may be observed, that in moulding the timbers, either before or abaft this joint or station, the moulds are made to the same line, as they are supposed to adjoin each other; but this method could not be true, supposing the timbers to be separated some distance apart; and it must be here also further observed, it being of the utmost consequence to the strength of the ship, that all the frame timbers should be preserved whole, and not cut or wounded by the ports, as the timbers appointed to make the sides of ports should run up to the top of the side, and are to be united or framed together into bends, before they are gotten up into their places in the ship: thus, those intended to make the sides of ports are called frame-timbers; and those cut off under the ports, or between the frames, are called filling timbers, the third futtocks of which, to increase the strength, should run up to the under-sides of the ports, if possible.

The room and space of this ship is 2 feet 9 inches, consequently the distance of every frame joint is 5 feet 6 inches; and it is at each of these stations that perpendiculars from the keel are drawn in the sheer plan; the timbers before ⊕ are alphabetically named A, B, C, &c.; and those abaft ⊕, or dead flat, numerally 1, 2, 3, &c. The timbers adjoining ⊕, which have no rising, are distinguished thus (A) (B), or (1) (2), and are likewise called flats.

In this ship ⊕ is a single timber, although it has been before observed this single timber is sometimes placed near the steps, or gangway. Observe, this single timber is introduced to change the bodies, as that before it is called the fore-body, so that abaft it is called the after-body: but this is not all; the floors in the fore-body are placed on the fore-side of the joint, consequently their moulding edge is on their aft-side, and the floors in the after-body are placed on the aft-side the joint, and their moulding edge is on their fore-side; therefore, in both bodies they become under bevellings; hence the necessity of this single timber to effect this change, or two floors would come together at the turn of the body, and the joint at their heads not strengthened by this intermediate shift of timber.

Now, as we do not mean to square up perpendiculars at the joint of every frame timber, we shall make use of as many as will suit our purpose in delineating the sheer plan. Therefore, set before the perpendicular ⊕ 19 feet 3 inches, and then square up from the upper edge of the keel a perpendicular, and under it mark F, as that is the station for frame F; then before F square up perpendiculars at 11 feet distant, marking under that next F, K, the next O, and the foremost one S. Then abaft the perpendicular ⊕ set off twenty 24 feet 9 inches, and then square up a perpendicular, and mark under it 6, as that will be the station for frame 6; then abaft this perpendicular set off 16 feet 6 inches five times, and square up perpendiculars at each station, marking that next abaft 6, 12, the others in succession 18, 24, 30, and the after one 36. These perpendiculars, or stations, are always referred to by those names hereafter.

Above the upper edge of the rabbit of the keel set up upon the foremost perpendicular 29 feet, the height of breadth at the stem, as both heights of breadths are terminated at one place quite forward and aft; next set up at S 24 feet 2 inches; at O 22 feet 8 inches; at K 21 feet 10 inches; at F 21 feet 3 inches; at ⊕ 21 feet 3 inches; at 6, 21 feet 3¼ inches; at 12, 21 feet 4 inches; at 18, 21 feet 6 inches; at 24, 22 feet 4 inches; at 30, 23 feet 9 inches; at 36, 26 feet 5 inches; and the after perpendicular 27 feet 10 inches. Then an elliptical curve drawn through those heights will show the lower height of breadth all fore and aft.

The rising line is the next curve to be drawn in the sheer plan, which, in a ship of this construction, gives the heights of the centres of the floor-sweeps, by the which curves the shape of the timbers at and near the floor-heads are formed in the body plan; thus, set up, as before, at K 21 feet 4 inches; at F 14 feet 7 inches; at ⊕ 11 feet 6 inches; at 6, 12 feet; at 12, 14 feet; at 18, 17 feet 6 inches; at 24, 24 feet 11 inches.

Then an elliptical curve drawn through those heights will determine the centre

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heights of the floor-sweeps; and although these lines may be termed imaginary lines, and not wanted in finishing the fabric, the necessity of drawing these lines, with their connected half breadths, &c. will appear, when we insist upon the nicety required in the formation of every line used in ship building; and by thus representing them, the draftsman, or constructor, avails himself of an opportunity of observing that the said lines make fair curves. We said above, that the rising line in a ship of this construction gave the heights of the centres for forming the floor-sweeps; but in full-built ships, or merchant ships in general, this rising line gives the rising or lifting of the floors towards their heads, above which one radius is given for limiting their curves, and from this very line the whole construction or form of the body at this place is given. Now, in the formation of this line, no undeviating rule is given; therefore, to construct it, a general knowledge of the formation of various bodies of different vessels is absolutely necessary. But what follows may be invariably observed, that is, the lifting of this line on the sheer plan, and narrowing it on the half-breadth plan, will procure velocity and less capacity; while lowering it on the sheer plan, and continuing its midship part parallel with the keel, and augmenting its breadth on the half-breadth, and continuing it in midships parallel with the middle line, will produce a full, or burthensome vessel; but then a vessel on this construction will not sail: hence the judgment required in constructing this part of the ship can only be acquired by practice.

Now the main half-breadth, and the half-breadth of the rising of this ship, may be drawn in the half-breadth plan: thus, draw a straight line, parallel to and as much below the upper side of the keel, in the sheer plan, as will admit of the depth of the keels a scale of feet and inches, by which the whole is to be drawn, and rather more than the main-half-breadth at ⊕, and this line will represent the middle line of the half-breadth plan, and is so called: then square down upon this line the several perpendiculars from the sheer plan, and it will also there represent the several timbers as sections crossing the timbers in the sheer plan at right angles.

Then for the main half-breadth set up from the middle line, for S, 20 feet 4 inches; at O, 23 feet; at K, 23 feet 10 inches; at F, 23 feet 11 inches; at ⊕, 24 feet; at 6, 23 feet 11½ inches; 12, 23 feet 11 inches; at 18, 23 feet 8 inches; at 24, 22 feet 9 inches; at 30, 20 feet 10 inches; and at 36, 17 feet 9 inches. Draw a curve through these several half-breadths, and the main half-breadth line will be described, except the fore and after parts. Permit us here to observe, the best method for drawing this and all other lines partaking of the nature of curves, is by elliptical moulds; or, what is better, when they are of any length, is by a thin pliable batton, confined down to the several spots, or dimensions, by square pieces of lead, about three or four ounces in weight; because by this last method the draughtsman has an opportunity of observing the fairness, or correctness of the line before he draws it. Our readers will excuse this particular description, because it need not be repeated, as all lines hereafter are supposed to be drawn in the same manner.

Now, to end the main half-breadth forward, proceed as follow: when the height of breadth cuts the fore-part of the rabbit on the stem, square it down to the middle line of the half-breadth plan, by taking its nearest distance from the adjoining perpendicular, and setting off that distance in the same manner from the same perpendicular on the middle line in the half-breadth plan, and there square up a line; then set up on it 10 inches, the half-siding, or thickness, of the stem at that place; from the middle line then, with compasses opened to 4 inches, the thickness of the plank of the bottom, sweep aft from the half-thickness of the stem an arch; then with a radius equal 26 feet 6 inches will finish the fore-part of the main half-breadth line; from the following centre draw a line at 4 feet 4 inches below, and parallel to the middle line of the half-breadth plan under timber O, and from timber O set forward 20 inches, and square it down to the line last drawn, and its intersection will be the centre required; then with radius 26 feet 6 inches, sweep the segment of a circle from timber S, till it will intersect the back of the arch at the thickness of the bottom plank; thus the main half-breadth line is completed, except the after end, which must be finished hereafter.

Next set off the half-breadth of the rising, which limits the distance of the centres of the floor-sweeps from the middle line on their respective heights in the body plan. Set up from the middle line of the half-breadth plan, at timber K, 2 feet 9 inches, at F, 7 feet 2

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inches; at ⊕, 8 feet 6 inches; at 6, 8 feet 5 inches; at 12, 7 feet 6 inches; at 18, 5 feet 3½ inches; and at 24, 8 inches; then drawing a curve through those spots, the half-breadth of the rising will be seen.

We may now proceed to drawing the vertical curve appearance those several timbers will form, below the lower height of breadth line in the body plan. Continue aft the upper edge of the rabbit of the keel line, and on it square up a line about 40 feet abaft the after perpendicular, and call this the middle line; then, at 24 feet distance, which is the main half breadth at midships on each side the middle line, square up a side line; then, within the boundaries of ⊕, on the right hand, will be delineated the several timbers which compose the fore-body; and within ⊕, on the left, those of the after-body.

Now transfer the several heights of the lower height of breadth line from the sheer plan at and before ⊕, and set them up the side line in the fore-body plan, drawing horizontal lines across at those heights to the middle line; then take the several main half-breadths from ⊕, and forward from the middle line of the half-breadth plan, and set them off from the middle line on their corresponding heights of breadth last drawn in the fore-body plan, and the utmost limits, or main breadth, of each timber will be shown.

Now draw another curve in the half breadth plan which shall be the radius or length, whereby portions of circles are swept, to form the shape of the body some distance below the main breadth. Set up from the middle line at ⊕ in the half breadth plan 18 feet 9 inches; at F, 18 feet; at K, 17 feet; at O, 15 feet 8 inches; at 8, 18 feet 11 inches; at 6, 18 feet 9 inches; at 12, 18 feet 7 inches; at 18, 17 feet 2 inches; at 24, 15 feet 3 inches; at 30, 12 feet 3 inches; and at 36, 7 feet. Draw a fair curve through these spots, and the length of all the sweeps may be obtained; then transfer the length at ⊕, and the timbers before it, and set them off with the half breadth of their respective timbers on their corresponding height of breadth lines in the fore-body plan, sweeping an arch about 7 feet below each height.

In the same manner transfer the heights for the centres of the floor-sweeps, from the sheer to the body-plan, and on those heights, from the middle line, set off the corresponding rising half breadths, their intersections between the centres, from which each floor may be swept by the following radii, without its rising half breadth, the radius at ⊕ is 11 feet, and what this is above the upper edge of the keel is called the dead rising. The radius at F is 13 feet 7 inches; at K, 20 feet 3 inches. Then, with a curved mould, sometimes called a reconciling sweep, (as in some bodies it might be a portion of a circle,) placed so as to cut the back of the lower and floor-sweeps, the timber ⊕ will be represented almost to the keel, and so may the other timbers as far as K; then, to complete them to the keel, set off the half siding of the keel, which is 9 inches, on each side the middle line in the body-plan, below the line for its upper edge, and draw a line on each side parallel to the middle line; then with compasses, opened to four inches, make two arcs, on each side, from the upper side of the keel, to cross each other towards the middle line; draw a straight line from the upper, and another from the lower side of the rabbit, to intersect the arcs at equal angles, and the rabbit of the keel will be shown. Then a straight line, or a mould a little hollow, (sometimes called floor-hollow,) placed to the siding of the keel at the upper edge of the rabbit, and to cut the back of the floor-sweep, the timbers as far as K may be completed as the keel.

Now, as the other timbers approach the stem in the fore body, and those towards the stern post in the after body differ in shape materially from those timbers near the midships, it will be necessary to draw in several horizontal or water lines, as they are called; for supposing the ship was floating on an even keel, and in an upright position, sections from side to side would thus be formed by the water. Here also we would show that every attention has been paid, and notice to our readers that vessels, in general, are found in their best sailing trim when they incline abaft from one to two feet, and sometimes more, particularly sharp constructed bodies, and that the upper one, being the load-water line, is drawn to this inclination, and that the several water lines below it have been kept parallel thereto; thus in the common mode of representing the water lines, in the half breadth plan, their correct shape at those places was not accurately ascertained; and as it is not necessary they should be so drawn, horizontal lines are more preferable, and more useful; therefore draw in the sheer-plan five horizontal lines, above the upper edge of the keel, 3 feet 8 inches asunder.

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Now, as these lines are parallel to the keel, they will be shown by straight lines parallel to each other across the body plan; otherwise, were they inclined lines in the sheer plan, they would form curves at their heights in the body plan; but in either case they form curves in the half breadth plan, limiting the half breadth of the ship at the height of their corresponding lines in the sheer plan; and these being the lines we are now about to represent, let their formation forward and aft be very nicely considered, for it is easy to conceive, as they approach the keel, and finish into the stem and stern-post, or vanish there, we may say they must taper very suddenly at those places, yet let not their form partake of hollow concave inflected curves but as little as possible, and not at all forward, as it has been proved a mistaken notion of giving velocity. Proceed then, as before directed, to set off on each corresponding timber from the middle line of the half breadth plan the following half breadths: and first, for the upper, or fifth water line, set off at S, 19 feet; at O, 22 feet 7 inches; at K, 23 feet 6 inches; at F, 23 feet 10 inches; at ⊕, 23 feet 11 inches; at 6, 23 feet 11 inches. Observe, between 6 and F the water lines are kept parallel, or nearly so, to the main half breadth line: set off at 12, 23 feet 10½ inches; at 18, 23 feet 4 inches; at 24, 22 feet 3 inches; at 30, 19 feet 7 inches; and at 36, 8 feet 5 inches. Now, to end the aft part correctly, square down, from the nearest perpendicular, where the aft-side of the rabbit of the post is cut by the fifth or upper water line, in the sheer plan, down to the middle line, of the half breadth plan, from whence square up a line, on which set up the half thickness of the stern-post from the body plan; but, in order to do this, set off the half thickness of the stern-post from the middle line, in the after body plan, thus: set off 11 inches at the head, and continue it parallel to the middle line as low down as the deck transom, which is 2 feet 2 inches below the upper side of the wing transom; from thence it is to taper with a straight line, to 7 inches on the upper side of the keel. Then the half thickness of the post may be taken at each water line, in the body plan, and set up from the middle line in the half breadth plan to its corresponding ending, as squared down from the sheer plan, where the water lines intersect the aft-side of the rabbit on the stern post; then, with a radius of 4 inches, sweep an arch within the half thickness of the post, on the half breadth plan, and the water line ends, intersecting the back of the arch, and a line squared out from the back of the water line, to cut the half siding of the post, would show the thickness of the bottom plank in that direction. Proceed to complete the fore part of the upper water line, with a 35 feet 6 inches radius, and ending of it similar as the main half breadth was; and, for the centre of the radius, draw an horizontal line at 11 feet 6 inches, under the middle line of the half breadth plan, with the above radius extended from the half breadth, or spot, given at timber S, gives the centre, where it cuts the line last drawn; then sweeping an arch from S to the rabbit, will complete the upper water line.

Proceed to set off the several half breadths and endings of the fourth water line as before; set up at S, 16 feet 8 inches; at O, 21 feet; at K, 22 feet 5 inches; at F, 22 feet 10½ inches; at ⊕, 23 feet; at 6, 22 feet 11½ inches; at 12, 22 feet 10 inches; at 18, 22 feet 2 inches; at 24, 20 feet 8 inches; at 30, 16 feet 8 inches; and at 36, 2 feet 11 inches. To sweep the fore part, draw a line under the middle line, in the half breadth plan, and parallel to it, at 21 feet 9 inches; then with a radius of 47 feet, from the half breadth at S, sweep in the fore part to the rabbit, as the paper on which the draught is drawn will not extend so low as this; in this case of sweeping in the fore part of half breadth lines, an additional sheet is placed underneath for this purpose. Ending of the water lines being all the same abaft, refer to the ending of the upper water line.

Proceed to set of the several half breadths and endings of the third water line; at S, 12 feet 4 inches; at O, 15 feet 8 inches; at K, 20 feet 3 inches; at F, 21 feet; at ⊕, 21 feet 5 inches; at 6, 21 feet 4½ inches; at 12, 21 feet 1 inch; at 18, 20 feet 3 inches; at 24, 18 feet: at 30, 12 feet; and at 36, 1 foot 5 inches. We must here remark, that, to complete this line forward with an arch, the radius would be too long for practice; it must therefore be finished by a mould or thin batten.

Proceed to set off the several half breadths and endings of the second water line. Set up at S, 7 feet 3 inches; at O, 13 feet 6 inches; at K, 17 feet 2 inches; at F, 18 feet 11 inches; at ⊕, 19 feet 3 inches; at 6, 19 feet 2½ inches; at 12, 18 feet 11 inches; at 18, 17 feet 8 inches; at 24, 14 feet 2 inches; at 30, 6 feet 2

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inches; and at 36, 8 inches; draw it as the last.

Lastly, for the first or lower water line: set up at S, 3 feet; at O, 8 feet; at K, 12 feet 6 inches; at F, 15 feet 3 inches; at ⊕, 16 feet 2 inches; at 6, 16 feet 1 inch; at 12, 15 feet 3 inches; at 18, 12 feet 0½ inch; at 14, 7 feet; at 30, 2 feet 1 inch; and at 36, 4 inches.

Now, all the water lines being drawn in the half breadth plan, and their delicacy of shape, if we may so term it, well examined, we may proceed to show whether they will likewise make fair timbers in the body plan: thus transfer the several half breadths of the water lines, as taken at ⊕, and set them off from the middle line, on their corresponding water lines, in the fore body plan, which will be found to answer with the shape of ⊕, already drawn; then proceed in the same manner with the other timbers before ⊕, drawing curves through the several half breadths, and ending them at the keel to the inside of the rabbit; but as timber S comes upon the stem in the sheer plan, the keeling will also come on the stem in the body plan; therefore its height must be taken above the line, at the upper edge of the rabbit, as continued before the stem, to where timber S intersects the fore side of the rabbit on the stem, and transfer that height to the fore body plan, to intersect the half thickness of the stem above the base line, or upper edge of the rabbit; in midships then, with a radius of 4 inches, sweep an arch from that height within the half thickness of the stem, then a line drawn through the several half breadths of S, and ending over the back of the arch, at the keeling timber, S will be drawn; and, to complete the keel, draw a square line from the back of the timber, to intersect the height of the keeling at the half thickness of the stem, and the timber S will be complete below the breadth. Thus, having the perpendicular fore and aft appearance of the several timbers in the fore body, they may now be strictly examined, and any unfairness readily pointed out; again, as a further proof, square up perpendicular lines close forward, about 2 feet asunder, or less, (the same may be done close aft hereafter, for the proof of the fairness of the water lines abaft,) then transfer the several half breadths, as before, from the half breadth to the body plan, and if they make handsome curves in the body plan, when drawn, the water lines may be said to be constructed with exactness.

But it may be necessary here just to describe to our readers what is meant by the term fair, as it often occurs in the formation of the several lines; which is, that all the lines should please the eye, having no inequalities, but produce a beautiful line, (one sense of the word fair,) and this is not an incongruous term, for Hogarth calls a curve, or serpentine line, the line of beauty, of which no architecture has such a variety as that of a ship.

Now complete the top sides, or upper part of the body and sheer plan, above the lower height of breadth. Thus, set off the upper height of breadth, in the sheer plan: at S, 25 feet 10 inches; at O, 24 feet 6 inches; at K, 23 feet 10 inches; at F, 23 feet 5 inches; at ⊕, 23 feet 4 inches; at 6, 23 feet 4 inches; at 12, 23 feet 4½ inches; at 18, 23 feet 6 inches; at 24, 24 feet 1 inch; at 30, 25 feet; and at 36, 27 feet 1 inch; and at the after perpendicular 28 feet 3 inches. Then, by drawing a curve through those heights intersecting the lower height of breadth, forward and aft, the upper height of breadth line will be represented. Then transfer these heights from the sheer to the body plan, and thereat draw horizontal lines across the body plan, then square up the several timbers from the lower to the upper height of breadth, as between those heights the timbers are straight, and of one breadth. Then, with a 15 feet radius, called the length of the upper breadth sweep, draw arches upwards, from the breadth squared up, and at that centre in each upper breadth line. Draw in the sheer plan the top-timber line, for it is at this height that the top side is limited to a certain breadth, called the top-timber breadth. Set up above the upper edge of the keel, in the sheer plan, at timber S, 37 feet 3 inches; at O, 36 feet 9 inches; at K, 36 feet 1 inch; at F, 35 feet 8 inches; at ⊕, 35 feet 6 inches; at 6, 35 feet 9 inches; at 12, 36 feet 4 inches; at 18, 36 feet 11 inches; at 24, 37 feet 10 inches; at 30, 38 feet 10 inches; and at 36, 40 feet. Draw a curve through these heights, and that will be the top-timber line in the sheer plan. Then set off the several top-timber half breadths, in the half breadth plan, by setting up at S, 20 feet 4 inches; at O, 21 feet; at K, 21 feet 11 inches; at F, 22 feet; at ⊕, 22 feet 2 inches; at 6, 22 feet 1½ inch; at 12, 22 feet; at 18, 21 feet 7 inches; at 24, 20 feet 8 inches; at 30, 18 feet 10 inches; at 36, 16 feet; and at the after end, 12 feet; and at the fore end, or beak head, 17 feet. Draw a curve

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through these several half breadths, and the top-timber half breadth will be represented. Transfer the several heights of the top-timber line from the sheer to the body plan, and at those heights draw horizontal lines; then from the half breadth plan transfer the several top-timber half breadths, and set them off from the middle line in the body plan upon their corresponding heights; then with a mould, about three inches curve, (called the top-timber hollow,) fixed well at the top-timber half breadth, and back of the upper sweep, at ⊕, draw a line to the top of the side, and ⊕ on the midship timber will be found from the keel to the gunwale.

Make a mould to ⊕, from the upper breadth upwards, some length above the gunwale, by which mould most of the timbers in the top-side may be drawn, by keeping them nearly parallel to each other, by so fixing the mould as to intersect the upper breadth sweep and top-timber half breadth. But observe, the top-timbers, as they approach the back-head in the fore body, they flair out, or curve the reverse of the midship timbers, and considerably so in ships with a beak-head; this not only gives more room on the forecastle, but assists the cat-heads to call the anchors clearer of the bow, and this flairing, though much less in other ships, has a tendency to keep off the spray of the sea, and make a dry forecastle.

Above the top-timber line in this ship, and sometimes at the plank sheer in others, the top-side is perpendicular; consequently an angle, called the knuckle, is formed at the intersection, and as many of the foremost timbers as partake of this shape, before they can be broken in fair with the others, are called knuckle timbers.

Forward and aft to the top-sides run higher than the top-timber line, set up their greatest heights to prove that their breadths at that place may make a fair line in the half breadth plan. Set up from F to forward, in the sheer plan, 2 feet 10 inches above, and draw a line parallel to the top-timber line; and from 12 to 24, in the after body, 4 feet 6 inches; and from 24, quite aft, 6 feet 6 inches; these risings above the gunwale, or the midships, are called drafts. Transfer those heights from the sheer plan to intersect their corresponding timbers in the body plan, as they are then limited by curves parallel to the top-timber line; then transfer their several half breadths to their corresponding timbers in the half breadth plan, and if curves drawn through those breadths should prove fair, the top-side is rightly constructed; if otherwise, each must be altered until they agree.

What remains to be described relates equally to both the fore and after bodies; for their being thus far completed, we have an opportunity of shifting the several timbers to the various lengths that compose them from the keel upwards, such as the floors, futtocks, and top-timbers. First, the length of the floors for a ship of this magnitude is 26 feet long at ⊕, or midships, and the lengths of those forward and aft may be determined by a diagonal line thus drawn in the body plan; set up the middle line above the upper edge of the keel 14 feet 6 inches, and on the base line, 14 feet on each side the middle line, draw lines to those spots, and the length of each floor is limited between those lines. Then, to determine the heads or lengths of the lower or first futtocks, set up the middle as before 22 feet 10 inches, and along the base line on each side 24 feet, drawing diagonal lines as for the floors, and the length of the lower futtocks are limited from the side of the keel to the diagonal line at their heads. Then, for the lengths of the second futtocks, set up the middle line 28 feet 8 inches, and up each side line from the base 10 feet, and draw the diagonals and the lengths of the second futtocks as limited from their junction at the floor-head, called the heel, to the diagonal last drawn or head. Then, for the lengths of the third futtocks, set up the middle line 34 feet 8 inches, and up each side 18 feet 5 inches; then diagonals, when drawn to these spots, will limit the length of the third futtocks from its heel at the first head. The fourth futtocks, when they can be gotten, are in one length from the second futtock head to the top of the side, and the top-timbers from the third futtock head to the top of the side.

The heads of the timbers being shown in the body plan, direct the stations for the ribbands thus: place the floor ribband about 20 inches below the floor head, and parallel thereto; then the next or first futtock ribband about midway between the floor and first futtock heads, and so with the others, keeping their heights forward and aft, the most convenient for supporting the heads and heels of the timbers, before they need be disturbed by working the planks outside.

Now these are called the ribband lines,

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and only appear as diagonal lines in the body plan, but they take their names from the ribbands, which are pieces of oak or fir timber, about 6 inches square, the longer the better; but those close forward and aft are called harpins, and are trimmed by moulds and bevellings to the form of the ship at those places. Ribband lines form curves on a ship's bottom by the intersection of a plane inclined, or canted, as shipwrights term it, to the plane of elevation, and their curves on the half breadth plan are denominated by them canted, or level, according as their several half breadths are taken off from the body plan, whether diagonally, or in a direction square from the middle line, which is a level or perpendicular to the plan of elevation; and although they agree in one and the same line on the ship's bottom, they represent very different curves in the half breadth plan.

Draw the ribband line at the floor head, in the half breadth plan, by taking these several half breadths from the middle line of the body plan, in the direction of the ribband line; thus we shall find ⊕, 16 feet; F, 15 feet 1 inch; K, 13 feet 11 inches; O, 10 feet 4 inches; and S, 8 feet 6 inches; in the fore body; and 6, 15 feet 9 inches; 12, 15 feet 1 inch; 18, 14 feet; 24, 11 feet 7 inches; 30, 7 feet 6 inches; and 36, 1 foot 11½ inches. Then set up these several half breadths on their corresponding timbers from the middle line in the half breadth plan; but what their endings differ from the water lines we will next explain. Take the height where the diagonal line, or ribband, cuts the half thickness of the stem in the body plan, and transfer that height to intersect the fore side of the rabbit of the stem in the sheer plan, from whence square down the fore side of the rabbit to the middle line in the half breadth plan, and then square up a line; then take the half thickness of the stem from the middle line in the body plan, in the direction of the ribband line, and set it up from the middle line in the half breadth plan on the line last drawn; then with compasses take the breadth of the rabbit in the direction of the ribband line, in the body plan, and sweep an arch from the half thickness of the stem, in the half breadth plan, and the back of the arch will be its ending forward; the ending abaft is so nearly the same, only that the heights are taken up the half thickness of the post in the body plan, and transferred to the aft side of the rabbit of the post in the sheer plan; proceed as before; now draw a curve line through all the half breadths, and intersecting the back of each arch, the ribband line at the floor head will be represented in the half breadth plan. In the same manner all the ribband lines may be represented. These lines will also prove the fairness of the bodies, but horizontal water lines should always have the preference, as they cut the body in a more acute direction, and its unfairness would be more readily discovered, for it is possible to have fair ribband lines to appearance, and the body itself remain unfair.

Hitherto the timbers have only been considered as perpendicular to the upper side of the keel, and square from the plane of elevation, or sheer plan, and hence called square timbers. But forward and aft, in the turn of the body, they are canted, that is, they incline aft towards the middle line in the fore body, and forward in the after body, in the half breadth plan, or form obtuse angles to the plane of elevation; the utility of this is to straigthen the form of the timbers, and reduce the bevellings, both highly essential in the conversion. Now to determine the situation of the cant timbers in the fore body, the foremost cant timber, which is Y, should be so canted as to stand as square with the main breadth line as possible, therefore it will be on that line before timber S, 15 feet 2 inches on a straight line, and at the side of the deadwood, which is 8 inches from, and parallel to, the middle line of the half breadth plan, 4 feet 10 inches before S; then the after cant timber, which is P, is before O at the main breadth, 2 feet 9 inches, and at the side of the deadwood, 2 feet 4 inches; draw straight lines to those spots, and the cant of the foremost cant timber Y, and the after one P, will be represented on the half breadth plan, the intermediate ones, which are 7, may be drawn by equally dividing them at the deadwood, between those already drawn, to where they shall intersect their respective square timbers, at the main breadth line, as here they remain at the same station, unless they are moved to make the side of a port.

The cant timbers in the after body may next be described in the half breadth plan, in order to which the cant of the fashion-piece, or after timber, must first be determined, observing, as in the fore body, to let it cant as nearly as possible square from the body at that place. Now, as the fashion-piece comes against the fore side of the transoms, the wing transoms must be drawn in the half breadth plan; thus

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set off from the middle line, in the half breadth plan at timber 36, 16 feet 6 inches, the half breadth of the wing transom, from thence level out a line aft, then, from the sheer plan, square down the aft-side of the wing transom at the post to the middle line in the half breadth plan, and at the side, on to the line last levelled out, then an arch drawn through these two spots, whose centre of radius is in the middle line, will represent the aft-side of the wing transom. Then draw in a horizontal line, in the half breadth plan, from a line at the side of the wing transom transferred from the sheer to the body plan, which is similar to a water line, then, from the aft-side of the transom, set forward upon the line last drawn, about 16 inches, and that is the aft-side of the fashion-piece at that place: then let the heel of it, setting off the half thickness of the deadwood as before, be set off before timber 36, 6 feet 2 inches, a line drawn through those spots is the aft-side appearance of the cant fashion-piece; then set off the cant of the foremost cant timber, which is 29, thus; abaft square timber 28, set off 2 feet 9 inches on the main breadth line, and 22 inches at the side of the deadwood, drawing a line which will represent the foremost cant timber, 29; then equally divide the heels of seven more on the deadwood between those already drawn, and likewise on the main breadth line, and the joints of all the cant timbers will be represented in the half breadth plan.

It was observed above, that the wing transom was limited by the aft-side of the fashion-piece, and so are all the other transoms, unless to assist their conversion by shortening those below the deck transom, which are six in number, by introducing fashion-pieces abaft that already described.

Now to complete the sheer plan, let the stern timber or shape of the stern at the aft-side be described thus; draw aft an horizontal line at the upper side of the wing transom at the post, and above it set up 4 feet, and draw another horizontal line, which will be the height of the lower counter; then set up from the wing transom 7 feet 6 inches, drawing another horizontal line, which will be the height of the upper counter, then set off abaft the aft-side of the wing transom 6 feet 10 inches, and square it up the line at the height of the lower counter, and the intersection with the knuckle of the lower counter; then, from the said knuckle, draw a curve line about 5 inches hollow, to intersect the upper side of the wing transom at the fore side of the rabbit on the stern post, and the lower counter will be represented at the middle line; then set off abaft the aft-side of the wing transom 8 feet 10 inches, and square up a line to the height of the upper counter, and their intersection will be the knuckle of the upper counter; then to the two knuckles draw a curve about 2 inches hollow, and that will represent the upper counter. Both counters being formed at the middle line, the upper part of the stern timber must be thus finished; set up, as before, 14 feet 7 inches, the height of the top-timber line aft, draw a horizontal line; then set off abaft the aft-side of the wing transom 11 feet, and square it up to the top-timber line; a straight line now drawn from the upper counter knuckle, and through the intersection at the top-timber line, and the stern timber at the middle line is complete.

Then observe, as the stern in its breadth rounds two ways, that is, both up and aft, the stern timber at the side will alter from that at the middle line, and must be thus drawn: take the round top of the upper counter, which is 10 inches, and set it below its knuckle at the middle timber in the sheer plan, and draw an horizontal line; then take the round aft, which is 16 inches, (on a level,) and set it forward from the knuckle of the middle timber, and square it down to the line last drawn, and where it intersects will be the knuckle of the upper counter at the side. In the same manner set down 8 inches for the round-up, and forward 15 inches for the round aft, and that will be the knuckle of the lower counter at the side; then a curve being drawn, similar to that at the middle timber, from one knuckle to the other, will form the upper counter at the side: then, to finish the lower counter at the side, set down 5 inches the round up, below the upper side of the wing transom in the sheer plan, and draw an horizontal line; then take 7 inches, the round aft of the wing transom, and set it forward from the aft-side of the wing transom upon its upper side, and square it down to the line last drawn, and the intersection will be the aft-side of the side stern timber; then a curve drawn similar to that at the middle from the side lower counter knuckle to the aft-side last set off, will represent the lower counter at the side. But as the straight line for the upper part of the side timber will not be parallel to that at the middle, owing to the stern narrowing upwards, its rake must be determined as follows; upon any straight line set off 26

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feet 8 inches, the breadth of the stern at the upper counter, and at the middle set off 16 inches, the round aft, then let an arch pass through this point and the half breadths of the stern on the line: this may be performed by a small drawing bow, or a mould swept with a radius equal to that segment. Now set off 12 feet, the half breadth of the stern at the top-timber line on each side the middle, to intersect the round aft at the upper counter, and through these intersections draw a line parallel to the other, and the distance from the line last drawn to arch in the middle is the distance that the side stern timber is from the after timbers, at the height of the top timber line; then a line, drawn through this spot to the knuckle of the upper counter at the side completes the side counter timber.

Now the fore and aft view of the side counter timber may be drawn in the boby plan, representing the half breadth of the stern. Draw an horizontal line across the after body plan, at the height of the upper side of the wing transom at the middle, thereon set off the half breadth of the wing transom from the half breadth plan, and there square down a line, and on that line set down 5 inches, or, what is the same thing, transfer the height of the wing transom at the side from the sheer plan; then sweep an arch to cut the upper side of the wing transom at the side and middle, the centre of the radius being found in the middle line of the body plan; then draw a horizontal line, as before, at the height of each knuckle transferred from the side timber in the sheer to the body plan; then transfer the heights of the knuckles of the middle stern timber from the sheer up the middle line of the body plan; then, to obtain the half breadth at each knuckle, the horizontal lines should be run from their heights in the body, to the half breadth plan, and their knuckles, squared down thereon from the sheer plan, and at those places their half breadth transferred to the body plan.—Thus we should find the half breadth at the lower counter knuckle 14 feet 6 inches, and at the upper counter knuckle 13 feet 5 inches; then set off these half breadths on their corresponding horizontals from the middle line in the body plan, and by sweeping arches as at the wing transom from the heights at the side and middle line, the round-up of each counter would be represented; then draw an horizontal line in the body plan, at the height where the top-timber line cuts the side stern timber in the sheer plan, and on it set off the half breadth of the top-timber line, which is 12 feet, as taken from the half breadth plan. Draw another horizontal line in the body plan, at the height of the top side, and on it set off 11 feet, its half breadth; then draw a straight line from the knuckle at the upper counter and the two half breadths above it, and the upper part of the timber will be formed, and from thence to the lower counter the same line may be continued, only having it to curve between the knuckles; then, to complete this timber between the knuckle at the lower counter and wing transom, three or more horizontal lines should be equally spaced and drawn across the body plan; then several half breadths taken and set off the half breadth plan, and curves drawn through them; then, when these horizontal lines intersect the side stern timber in the sheer plan, they must be squared down to their corresponding lines drawn in the half breadth plan, and their several half breadths there taken and set off on their corresponding lines in the body plan; then a curve passing through those spots from the knuckle of the lower counter to the wing transom at the side, completes the side timber in the body plan

Now to complete the half breadth plan and the main half breadth and top-timber line abaft, thus square down to the half breadth plan where the height of breadth, the top-timber line, cuts the side stern timber in the sheer plan, and from thence transfer its height to the stern timber in the body plan, and there take its half breadth, and set off from the middle line of the half breadth plan upon the line last squared, down which is its ending at the outside; from thence sweep a curve to the round aft of the stern at those places, and it is complete.

Now there only remains to complete the sheer plan, and the construction of the sheer draught or principal design will be completed; and first set up the heights and lengths of all the decks thus: above the upper side of the gun deck already drawn, set up 7 feet 1 inch, all forward aft, and draw a curve parallel thereto, which will represent the under side of the upper deck, and another curve, drawn 3 inches above, and parallel thereto, will represent the upper side of the upper deck; then above the upper side of the upper deck set up 6 feet 7 inches at timber F, and forward to the beak head; then draw a curve through these heights, parallel to the upper decks, and that will be the under side of the forecastle; then

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draw another curve 3 inches parallel above it, and that will be the upper side. Again, set up at timber 6, above the upper side of the upper deck, 6 feet 7 inches, and at the middle stern timber 6 feet 9 inches, and above those heights 3 inches, drawing curves as before, the quarter deck will be represented. Set up, at timber 24, above the upper side of the quarter deck, 6 feet 5 inches, and at the midship stern timber 6 feet 7 inches, and above those heights 2½ inches, and the round house deck will be represented as well as the before mentioned, at the middle line.

The ports next claim our attention, but before they can be drawn, the decks at the side must be represented, and to do this correctly, the round-up of the beam in midships, or the longest, must be represented by the segment of a circle, as was lately observed for the round aft of the stern.

Transfer the height of gun deck at ⊕ in the sheer, to the body plan, and then take the half breadth of the midship timber, and set it off twice on some straight line, and in the middle set up 6 inches, the round-up of the gun deck at that place, drawing an arch as before.

Then for the round of the deck, or the deck at the side in the sheer plan, set down below the under side of the middle, as already drawn at ⊕, 6 inches; and for the other timbers observe the following method: transfer the height of the under side of the deck from the sheer to its corresponding timber in the body plan, taking then its half breadth, and apply it from each side the middle to intersect the arch for the round-up of the beam at ⊕, drawing parallel lines to each intersection; then the distance taken in the middle, from the lines at the several breadths, being set down on their corresponding timbers, from the under side of the gun deck in the sheer plan, and a curve there drawn to pass through these several spots, will represent the hang or sheer of the gun deck at the side, and thus may the round-up of each deck, at the side, be shown in the sheer plan, according to its round-up at the broadest place.

Now for the under side of the gun deck ports, draw a curve line, 2 feet 8 inches above the gun deck line at the side, in the sheer plan; and another parallel line, drawn 2 feet 8 inches above the lower side, will show the upper side of the gun deck ports. Then for the fore side of the foremost port, set off 9 feet 5 inches before timber 8, and for its aft-side 6 feet 5 inches. Then for the fore side of all the ports abaft the fore one, set off 4 feet 5½ inches before the joint of every other frame, beginning at frame 32; then 3 feet 5 inches set off abaft each of their fore sides will give the aft side; then square up their sides between the lines drawn for their lower and upper sides, and all the 15 ports for the gun deck will be represented.

Then draw the upper deck at the side, as directed for the gun deck; and for the upper deck ports two curves parallel above the deck at the side, the lower one 2 feet 8 inches, and the upper line 2 feet 8 inches above that; then set off, before timber 8, 4 feet 4 inches for the fore-side of the foremost port, and 3 feet abaft it for the aft side, then continue to set off 3 feet, exactly midway, between each gun deck port, and one abaft the after gun deck port, and square up their sides, and 15 ports will be represented for the upper deck.

In the same manner must the quarter deck and forecastle ports, and even those on the round-house, if any, be drawn, keeping them at equal distances, as near as possible, as their situations must depend on keeping them clear of the shrouds. The quarter deck ports on each side are 7 in number, the lower side 23 inches above the deck, at the side 2 feet 7 inches deep, and 2 feet 10 inches fore and aft, and the same on the forecastle, only 3 in number.

Now the wales may be drawn in the sheer plan, and as the strength of the ship depends much on their situation, great care should be taken in not placing them so high as to be cut by the gun deck ports, and yet so placed as to take as many of the bolts as come through the gun deck knees as possible, and that they come as near on the broadest part of the ship as the foregoing circumstances will admit; therefore, for the height of the lower edge, set up above the upper edge of the keel, at the fore side of the rabbit at the stem, 22 feet 7 inches; at S, 21 feet 2 inches; at O, 20 feet 4 inches; at K, 19 feet 9 inches; at F, 19 feet; at ⊕, 18 feet 8 inches; at 6, 18 feet 8½ inches; at 12, 18 feet 10 inches; at 11, 19 feet 5 inches; at 24, 20 feet 4 inches; at 30, 21 feet 10 inches; and at 36, 23 feet 11 inches. Then a curve drawn through these heights will be the lower edge of the wale, and another curve, drawn 4 feet 4 inches parallel above it, will be the upper edge of the wale; but observe, the lower edge of the wale close aft curves up very quick, owing to the sudden turn of the body at that place.

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The heights and breadths of the channel wales may be next drawn; and as it may be readily seen from their situation they are intended to strengthen the top side, they therefore must be placed as nearly as possible between the lower and upper deck ports, and their lower edge along the midships should be placed so low as only to prevent their being cut by the upper stops of the gun deck ports, to prevent the upper edge being wounded by the upper deck ports, afore and abaft; therefore, for the height of the lower edge, set up above the upper edge of the keel, at the fore side of the rabbit on the stem, 30 feet; at 8, 29 feet; at O, 28 feet 5 inches; at K, 27 feet 11 inches; at F, 27 feet 6 inches; at ⊕, 27 feet 3 inches; at 6, 27 feet 6 inches; at 12, 28 feet; at 18, 28 feet 8 inches; at 24, 29 feet 8 inches; at 30, 30 feet 7 inches; and at 36, 32 feet. Then a curve drawn through these heights will be the lower edge of the channel wale, and another curve drawn 3 feet, parallel about it, will be the upper edge, thus the channel wale will be represented.

Now to complete the top side, the several rails, drifts, &c. remain to be described. Therefore set forward, from the aft side of the middle stern timber 51 feet, the length of the round-house, and this should be no longer than may be just sufficient for the necessary accomodations, as the shorter the round-house the lower the top side may be kept abaft; and likewise the stern, as a low snug stern always appears handsome, and is best; as a proof of this, and the objection to lofty quarters abaft, several ships of the navy have their round-houses taken away, and the top sides cut down. Set up above the top-timber line 6 feet 6 inches, and draw a curve at that height, parallel to the top timber-line, from aft to the fore end of the round-house; then draw another line, 2½ inches, parallel above it, and that will represent the plank sheer as far as the round-house.

Then, in order to lower the top side in a handsome manner, as it approaches the waist or lower part, have a fall or trance at the fore end of the round-house, turned off, with an inverted scroll, upon the plank sheer of the quarter deck, the under side of which is 4 feet 6 inches above the top-timber line, and parallel to it, to 3 feet 6 inches before timber 12, draw another curve, parallel 2½ inches, above the under side, and the plank sheer thus far will be represented, and house the ports at the fore part of the quarter deck. Then near the gangway let there be another fall or break at the fore part of the quarter deck, its extent 11 feet 6 inches before timber 12; then set up 3 feet 5 inches above the top-timber line, and draw a line parallel thereto, 6 feet 9 inches aft, and another line 2½ inches parallel above it, and the plank sheer will be completed from aft. Then set up 2 feet 11 inches above the top-timber line, and draw a curve, parallel thereto, to the first break before timber 12, and that will be under the side of the drift rail, and draw another line parallel to 4½ inches above that, and it will complete the drift rail thus far; then continue the drift rail as far as the main drift, by keeping its under side 2 feet above, and parallel to the top-timber line; now finish the main drift at the fore part of the quarter deck with a scroll, and the plank sheer above it with an inverted scroll; then complete the drift rail and plank sheer, at the next break, with a quarter round.

Then above the round-house, at the side, set up 4 feet 1 inch, and draw a curve parallel thereto, which will be the under side of the rough tree rail, and a line drawn 4½ inches above will show the thickness, or upper side, under which four ports on each side, about 6 feet 4 inches asunder, and 3 feet 4 inches fore and aft, may be drawn, observing they are clear of the mizen shrouds, and the after port clear of the upper finishing of the quarter gallery.

Now that the top side of the ship, forward, should bear a resemblance to the after part, and in order to give security to the forecastle, set up above the top-timber line, 2 feet 10 inches, and draw a curve, parallel thereto, from the fore side of the beak head to the aft part of the forecastle, and another line 2½ inches above, and parallel to the last, and the forecastle plank sheer will be represented; observe, the after part of the forecastle is 4 feet 8 inches abaft timber F, and the fore side of the beak head 10 feet 3 inches before timber S; then draw the under side of the drift rail 22 inches above, and parallel to the top-timber line, and a line 4½ inches above it will complete the drift rail, and the drift is to be finished like the drift at the fore part of the quarter deck. Then the ports, 3 in number, 2 feet 10 inches fore and aft, are represented by timber heads, as their situations must be govern-

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ed by the fore shrouds; the height of the timber heads is 22 inches above the plank sheer, one timber head being left to form the side of each port, and one between, and three or four before the foremast will be quite sufficient, and there may be two similar timber heads left up abreast the main-mast.

The sheer rail is represented by the top-timber line, and a curve drawn to 5 inches parallel above it, and the waist rail by curves 5½ inches asunder, drawn parallel below the sheer rail, at 22 inches in the clear. The rails and drifts being merely ornamental, they are often dispensed with in the navy, as the sides of the ship were found to decay very fast under them. Some have been painted only along the sides, but merchant ships, in general, have then wrought solid in the plank of the top side.

The channels may next be situated as the shrouds leading to them were lately mentioned, with regard to spacing the quarter deck and forecastle ports; and first, the centres and rake of the masts must be drawn in the sheer plan. The centre of the fore-mast is 22 feet abaft the aft-side of the stem on the gun deck and rakes, or inclines aft, from a perpendicular, with the upper side of the keel ⅛ of an inch, in every yard of its length from the centre given. The centre of the main-mast is 102 feet abaft the aft-side of the stem, on the gun deck, and rakes ⅜ of an inch in every yard of its length. And the centre of the mizen-mast is 27 feet before the fore side of the rabbit of the stern post, on the gun deck, and rakes aft ¾ of an inch in every yard of its length. Now let the upper edges of all the channels be kept well with the upper edge of the sheer rail; but in some ships the mizen channel is kept higher than the others, the better to station the quarter deck ports.

The length of the fore channel is 35 feet 6 inches, and its fore end fixed 3 feet 4 inches before the centre of the foremast at that place. The length of the main channel is 29 feet four inches, and its fore end 3 inches before the centre of the main-mast. The length of the mizen channel is 16 feet 6 inches, and its fore end 1 inch before the centre of the mizen-mast. The outer edges of the fore and main channels are 4½ inches thick, and outer edge of mizen channel 3½ inches thick; which thicknesses may be drawn parallel their whole length below the upper side. The dead-eyes, that is, their diameters, which are 16 inches the main and fore, and 11 inches the mizen, may next be drawn, observing to place their centres, that the rake of the chains may be clear of the upper deck ports, both chains and preventer-plates to rake in the direction of their shrouds, which is best done in the following manner: continue upwards, through the centre, the rake of the mast to the upper side of the tressel trees, which for the fore mast is 87 feet above the keelson; then draw a line about 2 inches more than half their diameter above, and parallel to the upper side of the fore channel: then on this line fix the centre of the fore dead-eye 10 inches abaft the centre of the fore-mast, and the centre of the second dead-eye 3 feet 9 inches abaft the foremost one's centre, and the centre of the third, fourth, and fifth, 2 feet 2 inches asunder; then lines drawn straight their centres, and crossing the height, set up the mast, gives the proper rake of each dead-eye, chains and preventer-plate; and although there are eleven dead-eyes in the fore-channel, their rakes and centres must be governed by the ports. The same rule must be observed in raking the dead-eye for the top-mast, backstay, &c. adding the height of the top-mast to the lower part of the head.

In the main channel are 12 dead-eyes, the centre of the foremost dead-eye to be fixed at 12 inches abaft the centre of the main-mast, and the centres of the remaining dead-eyes may be stationed four between each port, raking them by the same process of those in the fore-channel.

Here the main-top-mast, and top-gallant backstay dead-eyes, had much better be fixed on a stool, kept the height of the drift-sail above, as they will not only clear the ports better, but save a great and unnecessary consumption, in lengthening the main channel.

Lastly, the mizen channel, having 7 dead-eyes, the four foremost one are stationed between the quarter deck ports, next abaft the mizen-mast; and the other three, and mizen-top-mast backstay dead-eye, is stationed between the two next ports, fixing the centre of the foremost dead-eye about 4 inches abaft the centre of the mizen-mast, raking them as before described.

The keelson being lately mentioned, and not drawn before, let it be represented in the sheer plan thus: first draw in the cutting-down line, which is a curve

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that limits the height of every floor-timber, in the middle and upper part of the dead or rising wood, forward and abaft, and the under side of the keelson. Set up at timber S, 4 feet 6 inches: at O, 2 feet 11 inches; at K, 2 feet 2 inches; at F, 2 feet ¾ inch; at ⊕, 2 feet; at 6, 2 feet ¼ inch: at 12, 2 feet ¾ inch; at 18, 2 feet 3 inches; at 24, 3 feet 3 inches; and at 30, 6 feet. Draw a curve through these spots, and another at 18 inches, parallel above it, and the keelson will be thus far shown; but as the fore part scarphs into the stemson, that must likewise be represented; and first, by drawing a curve 11 inches parallel, abaft the aft side of the stem, from the head to timber O, we show the apron or inner stem; then another curve, drawn abaft the apron 13 inches, at the under side of the upper deck, and to break in fair with the upper side of the keelson, will represent the stemson. The after end of the keelson scarphs into the knee, against the foreside of the transoms.

We may now proceed to draw in that ornamental and useful part of the ship, called the head; and here beauty and lightness should be most considered. Draw in the under side of the bowsprit, as that cónfines the height of the figure: set up above the upper side of the upper deck, at the aft side of the stem, 2 feet 11 inches; and then draw a perpendicular, at 15 feet 8 inches before the fore side of the stem, at the upper part, which will limit the fore side of the figure; set up thereon, above the upper side of the keel, 42 feet 3 inches; then draw a straight line through these two heights, and it will represent the under side of the bowsprit; and another line drawn parallel above it, at 3 feet distance on a square, will show the diameter or upper side of the bowsprit. Now draw the knightheads, and let them be sufficiently in height as to admit a shock over the bowsprit, so as to secure it firm in its bed on the stem; to do this, we must first draw half the diameter of the bowsprit parallel to the middle line of the half breadth plan, and thereon square down the fore side of the rabbit of the stern, at the under side of the bowsprit, in the sheer plan, and there draw a section of the knighthead, about two inches within the bowsprit, as they must not be cut any more by the bowsprit; then by squaring up the fore sides and the aft side of the section, from the half breadth plan, to and above the stem in the sheer plan, and drawing lines parallel to the fore side of the rabbit, 4 feet 4 inches above the head of the stern, and the starboard knighthead will be represented.

The limits of the beak head should next be drawn thus; in the sheer plan draw a perpendicular, 6 feet abaft the aft side of the stem, at the upper part, and that will be the fore side of the beak head; set up above the upper side of the upper deck 20 inches, and draw a horizontal line from the fore side of the back head to the stem.

The cheeks being the basis of the head, their situation demands peculiar care, especially as the hawse holes come between them; therefore, before we can determine the situation of the lower cheek, the hawse holes must be drawn in the half breadth plan, and squared up to the sheer plan; then set up for the under sides, 2 feet 3 inches above the upper side of the upper deck, and 3 feet 8 inches for their upper sides; then the outsides of the hawse holes may be drawn in the sheer plan, and we shall see that the cheeks, as here to be drawn, are rightly situated: thus, for the under side of the lower cheek, set up from the upper edge of the keel, in the sheer plan, 25 feet, on the fore side of the rabbit, on the stem, and from thence draw an airy curve, rising, to break in fair with the perpendicular, at the fore side of the figure, near the head or the upper part; and this curve will represent the fore side or set of the figure. Abaft the stem, the cheek may be drawn to the sheer of the wale, to 4 feet 4 inches, its after end. The upper side of the upper cheek may be exactly in the middle, between the lower side of the lower cheek and the upper side of the main rail, the upper side of which is kept on a level with the beak head at the stem; then set down on the stem, below the upper side of the upper cheek, 11 inches, its siding or lower edge. Then draw a parallel line, 4 feet 4 inches abaft the perpendicular line, at the fore side of the figure, that will give the boundary of the hair bracket, except the scroll, and likewise the aft side of the figure: the scroll which finishes the upper part of the hair bracket should be gracefully turned over into the lower part of the neck, or between the shoulders of the figure. Square up a line from the after end of the lower cheek to the upper cheek, and then draw another curve line from the under side of the upper cheek at the stem, the after part kept nearly parallel to the flight of the lower cheek, gradually rising to break in fair with the

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perpendicular last drawn, and the underside of the upper cheek will now be represented. Then set off the heel of the figure, or length of the block from which the figure is to be carved, by squaring up a line from the under side of the lower cheek to the under side of the upper cheek, 7 feet 3 inches abaft the perpendicular, at the fore side of the figure. Then, to draw in the siding or upper sides of the cheeks, set up 12 inches, the siding of the lower cheek above its lower side at the stern, and 9 inches at the heel of the figure, or foremost end of the lower cheek; then a curve drawn to a regular taper, through those spots, describes the upper side of the lower cheek. In the same, draw in the upper side of the upper cheek, tapering regularly from 11 inches, its siding at the stem to 7 inches, its siding at the heel of the figure, or lower end of the hair bracket, the upper part of which at the scroll may be 5 inches; the hair bracket should be completed by a pleasing serpentine line, finishing with the scroll before observed. The head of the block, or upper part of the figure, may be completed by continuing the line at the breast of the figure, rounding it to the top of the hair bracket, which is 37 feet 6 inches above the upper side of the keel, observing to keep the upper part of the figure 6 inches below the under side of the bowsprit.

Having fixed on the upper side of the main rail at the stern, continue the bag or upper side of its level with the beak head, as far out as possible, for the conveniency of the gratings, gradually rising the foremost end nearly parallel with the flight of the upper cheek, terminating the foremost end into the scroll of the hair bracket; to complete the after end, describe the arch of a circle, that shall break in fair with the fore side of the beak head at the forecastle, and its upper side at the stem: the under side of the main rail is drawn by regularly tapering it from 12 inches, its moulding at the forecastle, to 7 inches, its moulding at the fore end; then continue the head of the main rail 2 feet 6 inches above the plank sheer, corresponding with the fore side of the beak head, and it is complete.

The stations of the head timbers may next be drawn thus: place the stem timber, or that nearest the stem, which is 7 inches, sided half its siding before the stem, and parallel to it, from the upper side of the upper cheek, to the under side of the main rail; then fix the fore side of the foremost head timber on the upper side of the upper cheek well with the heel of the figure, raking it forward its siding, which is 5 inches. The middle timber, which is sided 6 inches, may be now drawn exactly between the former two.

The two middle rails, between the main rail and upper cheek, may be next drawn, by dividing the distance equally between the latter at every head timber, curves then drawn, regularly tapering, as before, to their mouldings; they may be thus represented, as far aft as the side, which terminates the after end of the lower rail, about two feet abaft the stem timbers; and it may be now said, the rail above it also, as most ships now have the supporters under the cat-heads, to hang plumb, or nearly so; and although this may not finish quite so handsome as the rail continuing aft, and making the supporter, yet it is much stronger for supporting the cat-heads; but we shall here describe its method of ending as has been usual, and the cat-head must be shown in the sheer plan; and in order to do this, it must be first drawn in the half breadth plan; thus square down the aft side of the main rail, or beak head timber, from the sheer to the half breadth plan, squaring it across; and another line, 18 inches abaft it, which will be the fore side, and the latter, the after side of the cat-head, as upon the forecastle; then from the intersection of the fore side of the cat-head, with the outside plank, at the top-timber, half breadth, or upper side of the forecastle, at the side, sweep a curve, at 9 feet distant, or without the bow; for at this place the cat-head cuts the sheer; then square up a line that shall cut the arch last drawn, at 5 feet before the fore side of the cat-head; then a line drawn from its intersection, to where the fore side of the cat-head cuts the outside plank, shows what the cat-head casts forward; then a parallel line, drawn at 18 inches abaft it, on a square, will be the aft side, and to complete the cat-head on the half breadth plan, square the outer end. Now square upwards to the forecastle on the sheer plan, where the aft side of the cat-head cuts the outside plank on the half breadth plan, and likewise its outer ends; then level out a line where the cat-head cuts the upper side of the forecastle; at the side above this line set up 5 feet 10 inches on the perpendicular, squared up for the aft side at the outer end; then from that spot draw a line to intersect the aft side of the cat-

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head at the forecastle; and that will be the under side of the cat-head, showing what it stives in its length upwards; then draw a parallel line above that to 16½ inches, and the aft side of the cat-head will be shown; then join the perpendiculars at the outer end, agreeably to the sheer, and draw a line at the fore side, parallel to the aft side, and the under side of the cat-head will be represented. In the half breadth plan, draw the supporter under the cat-head, what it is to project the bow, which is 6 feet 6 inches, and its siding 10 inches, placing it in the middle of the cat-head; then square up its length and aft side to the under side of the cat-head, in the sheer plan, and draw a line parallel to the aft side of the cat-head, from thence to the side, its distance from the aft side of the cat-head. Then continue upwards the under side of the upper middle rail, with a curve parallel, or nearly so, to the aft side of the main rail; then draw the outer end of the supporter to the shape of a knee, and finish thereto the after end of the upper middle rail with a pleasing curve, resembling the after end of the main rail.

The knee of the head, or cutwater, remains now to be described. Let it project from the seating of the figure about 3 inches, which is at 35 feet 6 inches above the upper side of the keel; then draw a line across to the hair bracket with the sheer, and continue the upper side of the knee, or its cutting down, about 4 inches above, and parallel to the upper side of the upper cheek. Observe, in shaping the fore part of the knee downwards, it be not too full, as it is then liable to rub the cable very much; therefore let it not project; the fore side of the lower cheek only to have sufficient substance for the bobstay holes, which are 4 inches diameter. When the lower side of the lower cheek cuts the fore side of the stem, with a radius of 5 feet 4 inches, sweep an arch, then draw a handsome serpentine line from its projection, at the seat of the figure, downwards, that may cut the back of the arch last drawn, and its breadth at the upper water line, which is two feet before the stem at that place, continuing it downwards, nearer the stem, until it forms the gripe, which partakes of a circle of 4 feet radius as it approaches the fore end of the keel. Therefore let the keel be completed: its upper edge here is represented by the upper edge of the rabbit: but this is not the case in all ships; for East India ships have the rabbit in the middle of the keel, as well as in the middle of the stem; but observe, all heights are set up above the line representing the upper edge of the rabbit, whether in the middle of the keel or upper edge. Set down 18 inches from the upper edge of the keel, and draw a straight line parallel thereto, which represents the under edge of the main keel; then below that set down 5 inches, and drawing another parallel line, the false keel will be likewise represented. To limit the foremost end of the keel, square up a line that shall intersect the fore side of the stem, leaving as much of the keel below the stem as it is deep in midships, at least from thence square a line across the stem, and it will limit the fore foot; and the keel must there be that depth at least, to receive the lower part of the stem, which boxes into it with a scarph, as follows: set off from the fore end of the keel 6 feet 6 inches, the length the stem scarphs into the keel; and that the stem, by keeping its moulded breadth, should not wound the keel too much at its lower edge, let the under side of the stem be cut off parallel with the under side of the keel two feet from its after end. The false keel may project the main keel about three inches, to which the lower part of the gripe will unite, and be limited by the fore foot.

The scale which is drawn between the keel and half breadth plan we shall here describe, and very briefly, as most draughtsmen are acquainted with scales of this kind. Shipping draughts, in general, are drawn by a scale of one-fourth of an inch to every foot, in the length on the gun-deck, or between the perpendiculars; and the inches, at each end, divided into twelve parts, by seven lines drawn parallel to each other between the under side of the keel and the main half breadth, and one foot, or division at each end, beyond the perpendiculars, are divided each way in the middle by two diagonal lines, which produce 12 equal parts, or inches. Sometimes this scale is constructed with five lines, and the foot at each end divided into inches by three equal diagonal divisions: the thick, dark line, representing the under side of the keel, is generally continued round the scale by way of ornament.

Now, to proceed to finish the stem, quarter-galleries, &c.: first draw in the aft side of the quarter-piece at the outside, which you will find, by the rounding of the stern, to come 13 inches before the upper counter knuckle of the side stern timber, setting it off as before directed;

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then draw a line with pencil, for the present, parallel to the side stern timber upwards, as the projection of the outside of the quarter gallery is nearly parallel to the side, except towards the upper part of the quarter-piece. Then draw the projection of the upper counter rail at the knuckle of the middle stern timber, thus: draw a line, 2½ inches parallel, abaft the upper counter at the middle, which will represent the thickness of the plank of the upper counter; then draw the under side of the rail square from the upper counter, and to project enough to bury the plank in a rabbit: from thence set up 8 inches, the breadth of the rail, and to intersect it set off 7 inches, its thickness, drawing the upper side to the sheer; then from this projection draw lines parallel to the knuckles, till they intersect the line drawn for the aft side of the quarter piece; thus the round up of the aft side of the upper counter rail will be represented in the sheer plan. From the intersection of the upper side of the upper counter rail with the aft side of the quarter-piece draw a straight line forwards, parallel with the sheer, or top-timber line, and that will represent the upper edge of the lower gallery rim: upon that line set off before the quarter piece 16 feet 9 inches, the length of it on the side; then the under side of the rim will be shown by a line drawn parallel to 8 inches below it.

In the same manner draw a section of the lower counter rail its under side to be square from the knuckle of the lower counter at the middle stern timber, and to project enough to bury the plank of the lower counter, the thickness of which will be represented by drawing a line to 4 inches parallel, abaft the lower counter, at the middle; from thence set up the breadth of it, which is 8½ inches, and thereto project 8 inches, its thickness; from thence draw lines parallel to the knuckles of the lower counter to the counter at the side, drawn parallel, what the quarter piece projects, or as much as the lower counter rail rounds forward at the outside; then draw a line 2 feet 10 inches below and parallel to the upper side of the lower gallery rim, and another likewise 8½ inches below it, and that will show the lower counter rail, as continued round the quarters, called the lower stool rail; set off from the aft side 13 feet, the length of this rail on the quarter. Then draw in the lower finishing, which should be as light and airy as possible: and first set down 10 inches below the rail last drawn, and draw a line parallel thereto, and another also 4 inches below it, which is the thickness of the stool. Draw a line parallel to the rake of the quarter piece, at 7 feet 11 inches, set off square before it, and this will give the rake of the quarter in the middle of the lower gallery, and likewise the middle of the lower finishing. Set down 13 inches below the stool, and in the direction on the line last drawn; then draw a handsome serpentine line from the under side of the lower counter rail at the side, through the spot last set off, continuing it upwards nearly to the fore end of the lower stool rail, the lower finishing will be completed; and then draw a curve 4 inches abaft, and parallel to the lower counter at the side, and the stern will be finished below the lower gallery rim.

Then set up the aft side of the quarter-piece, and with the rake from the upper edge of the lower gallery rim, 5 feet, and draw a line along the quarter, parallel to the sheer, or lower gallery rim, and another line in the same direction 8 inches above it, and its length 16 feet 9 inches, from the aft side of the quarter piece, and that will represent the middle stool rail, and a continuation of the foot-space rail from aft round the quarters. Hitherto the quarter piece has been considered as one length, from the upper part to the lower gallery rim; but as that would make it very heavy, and of an unnecessary length, lets it heel, or lower end, terminate on the middle stool.

Now set forward the siding of the quarter-piece, which is 16 inches, on a square, and draw a line to that, siding parallel to the aft side, which represents the fore side of the quarter piece; continue down the fore side line from the under side of the middle stool rail to the upper side of lower rim rail. Then set up the fore side of the quarter piece on the rake, 3 feet 2 inches above the upper edge of the lower rim rail, and above that 7½ inches, and draw two lines forward, parallel to the lower rim, to 12 feet 2 inches before the fore side of the quarter piece, and they will represent the upper gallery rim. Then above the upper rim, and parallel to it, draw the upper stool rail thus: set up the fore side of the quarter piece, and on the rake 3 feet 10 inches from the upper edge of the upper rim, and 6¾ inches, its depth above it, and draw two parallel lines from thence to 12 feet 2 inches before the fore side of the quarter piece. Above the upper stool draw the upper finishing thus: set up the rake at the

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fore side of the quarter piece, 12 inches from the upper side of the upper stool, and below that height 4 inches; then draw two lines from thence, parallel to the upper stool, to 10 feet 8 inches before the fore side of the quarter-piece; in the same manner, and from the same place, as above, set 23 inches, and 2½ inches below it, and the pulpit rail, or upper rail of the finish, will be found to answer with the height of the plank sheer; then set forward from the fore side of the quarter piece 10 feet 2 inches; then draw between those two rails a line parallel to the rake of the quarter, about 3 inches within the forwards; then finish the fore part of the quarter, from under the side of the middle rail of the upper finishing to the upper side of the upper stool rail at the fore part by an ogee curve, and the upper finishing will be complete.

Now, as the upper rim shortens so much more than the lower rim, in order to make the upper gallery lighter and smaller, connect the under side of the upper rim at the fore side with the middle stool rail with an airy raking curve; then the munions and gallery lights remain only to be represented, to complete the quarters. And first draw the fore side of the lower gallery by a line set off on the sheer 14 feet 2 inches before, and parallel to the fore side of the quarter-piece, from the upper side of the lower rim to the under side of the middle stool rail; and set aft 12 inches on a square from this line, and draw another parallel thereto, and this will show the foremost munion of the lower gallery: then divide between the aft side of this munion and the fore side of the quarter-piece into three lights, having a twelve inch munion between each light, and then the light will be about 2 feet 11 inches, in the clear, on a square: then draw the bottom of each light about 6 inches above, and parallel to the lower rim, for the water table, and their upper parts about 4 inches below the middle stool rail.

The lights of the upper gallery may next be drawn in a similar manner. Thus, draw the fore part as before, which is 11 feet 7 inches before the fore side of the quarter-piece, then set aft 10 inches on a square for the foremost munion and space, between that and the fore side of the quarter-piece, three munions of 10 inches broad each, and three lights about 2 feet 2 inches in the clear; draw the bottom of the lights about 5 inches above the upper rim, and the upper part of the lights about 3 inches below the under side of the upper stool rail; hence the quarters are complete. To finish the stern abaft, and above the upper counter, set abaft the middle stern timber on the upper side of the quarter deck, 2 feet 6 inches, and draw a line upwards parallel to the aft side of the timber, and this line will be the projection of the balcony. On this line set down, below the under side of the quarter deck about 1½ inch, from whence draw a curve that shall cut the side stern timber at 1½ inch below the under side of the quarter deck at that place, and to break in with the under side of the middle stool rail, at the aft side of the quarter piece; then draw another curve nearly parallel above it, from the upper side of the middle stool rail, to project 2 inches abaft the balcony, and it will represent the aft side view of the foot space rail, as far as the middle line. Draw an horizontal line at the upper side of the foot space rail abaft, then take the upper side of the middle rim above the middle stool rail, and set it up in the same manner above the horizontal line last drawn, to cut the aft side of the balcony, and from thence draw a curve parallel to the foot space rail, to the inside of the quarter-piece, which is represented by a line drawn parallel to the aft side of the quarter-piece, at about 4 inches within it; then draw another curve parallel below the former, to the depth of the upper rim, and the breast rail of the balcony will be represented also. Then draw a parallel line 3 inches abaft the middle stern timber, from the under side of the foot-space rail down to the upper counter rail, and that will show the after munion at the middle of the stem.

Now draw in the taffrail and upper part of the quarter-piece, which unite in one view at the side. Set up 3 feet above the upper side of the round-house, at the middle stern-timber, and draw a line to the sheer, which will be the upper side of the taffrail; then draw a line 3 inches abaft the middle timber, and parallel to it, which will be the aft side of the taffrail birthing; then set up the side stern-timber on its rake, 3 feet above the breast rail, for the cove, or arching, of the quarter-piece; then from the under side of the taffrail, which may be about 1½ inch below the under side of the round-house transom, draw a curve to the truss munion on the side-stern timber, then set down two feet below the upper side of the taffrail, and from thence draw another curve, to break in with the former at the truss munion, which represent the

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taffrail cove rail; then set up five feet above the breast rail, at the side stern timber on the rake, and finish the upper part of the quarter-piece to this height by a round parallel to that at the cove: then draw a curve from the aft side of the taffrail down to 3 inches abaft the upper part of the quarter-piece at the side timber, and another curve, parallel before it, to the siding of the quarter-piece, and the stern will be complete.

The rudder now remains to be drawn in the sheer plan, which represents its breadth, and how it is attached to the stern-post. Set up from the upper edge of the keel 19 feet 6 inches for the lower hance, which is generally kept a little above the load water line; then set up 25 feet for the upper hance; then set aft, from the aft side of the stern-post, its breadth at the keel, which is 5 feet 8 inches, and at the lower hance 4 feet; then draw a line to those two breadths, and a parallel line 3 inches abaft it for the back, and the rudder is formed below the lower hance, except the heel, which at the fore side may come as low down as the middle of the main keel, and cut off with a line 4 inches short of that at the aft side, below which is fixed a sole, equal in depth to the false keel: this is to prevent it striking, if the ship touches the ground. Then draw a moulding at the lower hance, so as to reduce the breadth to 3 feet 4 inches; then set aft 3 feet at the upper hance, and join the two last breadths by a straight line; then reduce the upper hance, with an ogee moulding, to 2 feet 6 inches; then set off 2 feet 4 inches, the breadth at the head; now the head must run up high enough to take a tiller above the upper deck; therefore set up above the deck 3 feet, and continue upwards the aft side of the stern-post, which will represent the fore side of the rudder; then set aft the breadth of the head as above, and join it with a straight line to the breadth at the upper hance, and the aft side of the rudder will be represented. The pintles and braces may next be drawn; and as the straps of the upper brace must come round the head of the standard on the gun deck, and, meeting in the middle, become a double security to the brace, therefore its under side may be about 3 inches above the upper side of the wing transom: then fix the under side of the lower brace about 8 inches above the upper side of the keel; then the others, which are five in number, may be placed at equal distances between the upper and lower braces; their length may be represented by setting off, before the aft side of the post, the length of the lower brace, which is 7 feet, and the second brace, which is 4 feet 6 inches; then, by drawing a line to these two, the intermediate ones will be governed by it; then set up the breadth of the straps, which is $4\frac{1}{2}$ inches, drawing them parallel to the lengths above mentioned, and square from the aft side of the post. The pintles are next drawn $4\frac{1}{2}$ inches, the breadth of the straps, immediately above the braces, and parallel thereto, across the rudder, and extend within two inches of the back. The pintles are $3\frac{3}{8}$ inches in diameter, and 13 inches long, except the lower one, which is 15 inches long.

The steps of the side being mentioned, we will describe their situation. Before we can say the sheer draught is complete, the steps must be fixed to the side, at the fore part of the main drift, and in length what the distance between the ports will admit; they are generally placed five inches asunder, and 6 inches deep, and continued from 11 inches below the top of the side to the upper edge of the lower or main wales.

The chestree may be also drawn, which must be placed at a proper distance before the main-mast, for hauling home the main tack; therefore place it the most convenient abaft the break of the forecastle which in this ship is 5 feet; it is sided 10 inches at the upper part or top of the side, and taper to six inches at the lower part or upper edge of the channel wales.

Lastly, the anchor-lining is a birthing of three inch plank, projecting from a bolster on the side, at the upper edge of the channel wales, to the outside of the fore channel, and is to convey the peak of the anchor on to the plank sheer, to stow it clear of the side; and as it determines the length of the fore channel, it should always be drawn on the sheer plan by a radius equal to the length of the anchor from the ring to the peak of the fluke, allowing for the cat-block at the outer end of the cat-head; and the lining should be so placed up the side, that the peak of the anchor may sweep up the middle of it: the foreside is finished agreeably to this sweep, and the aft side is shown perpendicular.

The cat-block may be likewise drawn abaft the main rail of the head, and the timber-head adjoining upon the plank sheer of the forecastle, and the sheer draught may be said to be completed.

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SHIPS. Wilfully destroying a ship, with intent to prejudice the insurers; plundering a ship in distress; stealing goods of the value of 40*s.* from on ship board; burning or destroying any of his Majesty's shipping or stores; are, by a variety of statutes, made felony, without benefit of clergy.

SHIP *money*, an imposition charged on the ports, towns, cities, boroughs, and counties of this realm, in the time of Charles I., by writs, commonly called ship writs, under the great seal of England, in 1635 and 1636, for providing and furnishing certain ships for the King's service, &c. which was declared to be contrary to the laws and statutes of this realm, the petition of right, and liberty of the subject.

SHIRE, in geography, signifies the same as county; being originally derived from the Saxon *seiran*, to *divide*.

SHIVERS, or SHEEVERS, in the sea-language, names given to the little rollers or round wheels of pulleys.

SHOAD, among miners, denotes a train of metalline stones, serving to direct them in the discovery of mines.

SHOAL, in the sea-language, denotes a place where the water is shallow.

SHOE *for an anchor*, in a ship, the place for the anchor to rest, and fitted to receive the stock, &c. so as to prevent the sheets, tacks, and other running-rigging, from galling or being entangled with the flukes.

SHOOTING. See GUNNERY and PROJECTILES.

SHOOTING. See SPORTING.

SHOOTING, maliciously, at persons in any dwelling house, or other place, though death should not ensue, is felony without clergy, by 9 George I. c. 22, commonly called the Black Act.

SHOPLIFTERS, those who steal goods privately out of shops. If the goods are of the value of 5*l.* though no person be in the shop, it is felony without benefit of clergy. 10 and 11 William III. c. 23.

SHORE, a place washed by the sea, or by some large river. Count Marsigli divides the sea-shore into three portions; the first of which is that tract of land which the sea just reaches in storms and high tides, but which it never covers; the second part of the shore is that which is covered in high tides and storms, but is dry at other times; and the third is the descent from this, which is always covered with water. The first part is only a continuation of the Continent, and suffers no alteration from the neighbourhood of the sea, except that it is rendered fit for the growth of some plants, and wholly unfit for that of others, by the saline steams and impregnations; and it is scarcely to be conceived by any, but those who have observed it, how far on land the effects of the sea reach, so as to make the earth proper for plants which will not grow without this influence; there being several plants frequently found on high hills, and dry places, at three, four, and more miles from the sea, which yet would not grow, unless in the neighbourhood of it, nor will ever be found elsewhere. The second part or portion of the shore is much more affected by the sea than the former, being frequently washed and beaten by it. Its productions are rendered salt by the water, and it is covered with sand, or with the fragments of shells in form of sand, and in some places with a tartarous matter, deposited from the water: the colour of this whole extent of ground is usually dusky and dull, especially where there are rocks and stones, and these covered with a slimy matter. The third part of the shore is more affected by the sea than either of the others, and is covered with an uniform crust of the true nature of the bottom of the sea, except that plants and animals have their residence in it; and the decayed parts of these alter it a little.

SHORL, in mineralogy, occurs commonly in granite, gneiss, and other similar rocks; often in mass, but very frequently crystallized. The primitive form of its crystals is an obtuse rhomboid, the solid angle at the summit of which is 139°, having rhomboid faces, with angles of 114° 12′ and 65° 48′: but it usually occurs in three, six, eight, nine, or twelve sided prisms, terminated by four or five-sided summits, variously truncated.

SHORL, *black*. Colour black. Found in mass, disseminated and crystallized. Crystals three-sided prisms, having their lateral edges truncated. Sometimes terminating in a pyramid. It becomes electric by heat. When heated to redness, its colour becomes brownish red; and at 127° Wedgewood, it is converted into a brownish compact enamel. According to Wiegleb, it is composed of

Alumina - - - - -	41.25
Silica - - - - -	34.16
Iron - - - - -	20.00
Manganese - - - -	5.41
	100.82

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SHORL, *electric*. This stone was first made known in Europe by specimens brought from Ceylon; but is now found frequently forming a part of the composition of mountains. It is sometimes in amorphous pieces, but much more frequently crystallized in three or nine-sided prisms, with four-sided summits. Colour usually green; sometimes brown, red, blue. Found in mass, in grains, and crystallized. Crystals three, six or nine-sided prisms, variously truncated. Its texture is foliated. Specific gravity 3. Colour brown, sometimes with a tint of green, blue, red, or yellow. When heated to 200° Fahrenheit, it becomes electric, one of the summits negatively, and the other positively. It reddens when heated, and is fusible *per se*, with white intumescence, into a white or grey enamel. According to Vauquelin, it is composed of

Silica	40
Alumina	39
Oxide of iron	12
Lime	4
Oxide of manganese	2.5
	97.5
Loss	2.5
	100

SHORLITE, a stone which received its name from M. Klaproth, is generally found in oblong masses, which, when regular, are six-sided prisms, inserted in granite. Its texture is foliated. Specific gravity 3.53. Colour greenish or yellowish white; sometimes sulphur yellow. Not altered by heat. It is composed of

Alumina	50
Silica	50
	100

SHORT-HAND, STENOGRAPHY. When mankind had acquired a tolerable degree of expertness and exactness in the use of letters by the ordinary modes of writing, it became the study of the curious to invent more concise methods of denoting the same words or phrases. Hence sundry schemes of abbreviation for compendious writing were devised; and the learned of different nations introduced them into their respective languages, according as more skill and greater perfection in writing them were acquired. Buxtorf has written a learned history of Hebrew abbreviations, as a key to understand the Rabbinical authors. Some of them are the incipient letters of several words, joined together as one, and marked at the top with points; others are the final letters of words; and others, again, are contracted words, wherein two or three letters are made to denote an entire word. The Jews were particularly partial to these methods of abbreviation, to which they added a few arbitrary characters, to express certain proper names, such as God, Jehovah, &c.

This kind of writing was, by degrees, introduced, and successfully practised among the Greeks. Nicolai gives it as his opinion that Xenophon first taught the Greeks to write by certain notes, in the nature of characters. Laertius confirms this opinion, and particularly mentions two methods of short writing, *viz.* one by contractions of words, and the other by arbitrary marks. This art was practised among the Romans at an early period. Indeed the first invention of a system of short-hand, by which the writer was enabled to follow the most rapid speaker, has been ascribed by some to the poet Ennius, and it is said that it was afterwards improved by Tyro, Cicero's freed man; and still more so by Seneca. Ennius began the practice with one thousand one hundred marks of his own contrivance. As an elucidation of this subject, and to show in what estimation this art was held among the Romans, we may briefly notice two of the Roman Emperors, of very opposite characters; Caligula, and Titus Vespasian. It was deemed a great defect in one of them, to be ignorant of short-hand; and a perfection in the other, to be acquainted with this highly useful and ingenious art. Caligula was a man guilty of so many vices, that it might be imagined his ignorance of short-hand would not have fallen under the notice of an historian. And yet Suetonius mentions it as something remarkable, that he who was so expert in other matters, and wanted not capacity and parts, was totally ignorant of short-hand. Titus Vespasian, on the contrary, was remarkable for writing short-hand exceedingly swift. He was indeed a true lover of the art, and made it not only his business, but his diversion. It afforded him great pleasure to get his amanuenses together, and entertain himself with trying which of them could write fastest; so that by common practice, he acquired such a command of hand, and such a facility in imitation, that

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he was wont to joke upon himself and say, what a special counterfeit he should have made.

The different schemes of short-hand formerly used, were probably much of the same nature, exceedingly *arbitrary*, and, for the most part unintelligible to any but those who practised them; and, for that reason, were soon forgotten and destroyed. We may guess at the fate they generally experienced, by two books of short-hand mentioned by Trithemius. The first was a dictionary of short-hand, which he bought of an abbot, who was a doctor of law, for a few pence, to the great satisfaction of the community to which he belonged, who had ordered the short-hand marks to be erased, for the sake of the parchment on which they were written. The other was a short-hand copy of the book of Psalms, which he met with in another monastery, where the learned monks had inscribed upon it, by way of title, "A Psalter of the Armenia Language!" Several copies of a dictionary and psalter, in the Roman short-hand, are mentioned as extant in different libraries; but they are, in general, the same method, as may be judged by the accounts of those who mention them, and also from the appearance of the hand-writing of an old short-hand psalter, in the library of St. Germain's at Paris, a few pages from which were transcribed for the use of the writer of these observations.

Plutarch, in his life of Cato, informs us, that the celebrated speech of that patriot, relating to the Catalinian conspiracy, was taken and preserved in short-hand. There are numerous epigrams of Ausonius, Martial, and Manilius, descriptive and commendatory of short-hand. Probably the most ancient method of short-writing at present extant, is a Latin MS. entitled "Ars Scribendi Characteris;" or, "The Art of Writing in Characters." The author of this tract is unknown; but we believe, it was printed about the year 1412.

The ancient Irish alphabets, particularly the first, which was purely stenographic, named Bobeloth, have a strong resemblance to many of our modern short-hands, but they are now little known. A specimen of this writing may be seen in Ledwich's Antiquities, p. 98.

M. Lambinet, in his Researches upon Printing, observes, that modern stenography, which, like the telegraph, dates in France from the foundation of the republic, has neither the inconvenience, nor the obscurity, nor the danger, of the ancient. The old characters varied under the hand of the copiers, and the sense changed according to the genius of the interpreters; so that their contractions are become so many enigmas, because we can refer to no other copies to ascertain the true reading, and because the authors are no longer in existence. "But," continues Lambinet, "by the present system of stenography, the writers follow the words of the public orators, take down their speeches, the motions, the debates of the tribune, or the lectures of the professors at the Lyceum, and produce a literal translation at last, in the usual characters, and in print." What the improved short-hand is, to which this French writer alludes, we are not informed.

The ingenious attempt of the late learned Bishop Wilkins, towards a real character and philosophical language, has much the appearance of some short-hands now in use. How far this attempt might have been successful we know not, had the contrivance been carried to that degree of perfection of which the Bishop thought it capable. The reader may find a specimen of this philosophic character in Stower's Printer's Grammar.

The shortest and most curious mode of writing, not professedly stenographic, which we have hitherto seen, is the specimen of ancient Welsh, by the ingenious Mr. W. Owen. This also may be seen in Mr. Stower's Grammar, p. 294.

The art of short-writing was first attempted to be published in this country in the year 1588, in a treatise entitled "Characterie, or the Art of Short, Swift, and Secret Writing, by Character, by Timothy Bright, M D." Two years after the appearance of Dr. Bright's treatise, Mr. Peter Bale published his "Writing Schoolmaster," which he divided into three parts: the first of which he entitled "Brachygraphy," containing rules to write as fast as a man can speak, with propriety and distinction. In 1618, appeared Willis's "Stenography, or Short-hand Writing, by spelling Characterics." This system consisted of ten alphabets, denominated words of sort; seven of which were composed of the initial letters of words; the rest principally by the omission of unnecessary letters, and by symbolical figures. This system was attempted to be improved upon by Henry Dix's "Brachygraphy." Omitting the mention of numerous other methods of short-hand writing that soon followed these several schemes, we must proceed

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to lay before the reader such a system of stenography, as, if generally known, would supersede the necessity of every other system; having been the result of great labour and ingenuity, as well as recommended, and its practical utility sufficiently demonstrated, by the practice of some of the first literary characters of our age, and the best judges of the art. This system is that invented by the late ingenious and worthy Mr. John Byrom, M. A. F. R. S. commonly known by the appellation of Doctor; availing ourselves, at the same time, of the very judicious improvements introduced by Mr. Molineaux, of Macclesfield, whose introduction to Byrom's short-hand is certainly the most beautiful and complete work on the subject ever yet produced to the public. It is published for the author, by Longman and Co. London.

The short-hand alphabet, as exhibited in the annexed plate, consists of the shortest and simplest marks in nature; and on the proper formation and combination of these characters depend the beauty and accuracy of the writing. We will endeavour to lay down such directions as appear necessary to acquire a general knowledge of the art; referring our readers to Mr. Molineaux's Treatise, for more ample instructions on the subject.

The great end of short-writing being to convey the sounds of words by the fewest, as well as the most simple characters, all those letters, which are not distinctly sounded in pronunciation, are to be omited, except in a few cases, where either the word would be rendered ambiguous, or present an unsightly appearance, without certain of its quiescent letters: for instance, it is evident that the letters *w a k-d*, properly joined together, might be allowed to represent *walked*, provided the reader could always remember to sound the *a* broad as in *wall*; but as the word, so contracted, might easily be mistaken for the word *waked*, it is always best to spell it with the letter *l*; thus, *walk'd*. This example will suffice for other words of the like nature. The omission of vowels, especially in the middle of words, has been a fault too common with writers on the present subject: yet it must generally be observed, that in short-writing it is proper to insert those vowels only, which are absolutely necessary in the pronunciation, which is a great saving of time, as well as conducive to the beauty of the writing. It is sometimes convenient, for the sake of facility in joining, to substitute one letter for another: as *k* for *q*, *ks*, *x*, &c. yet this should never be resorted to, but for some obvious advantage of beauty or brevity.

The short-hand alphabet, as some suppose concerning the Hebrew, consists of consonants only, the vowels being supplied by dots differently placed. These consonants running neatly into each other, will form the marks for words, never lifting the pen in writing a word, except in a very few instances, and for the sake of preserving the beauty of the writing, which will always be attended with a correspondent degree of brevity and legibility; a circumstance, perhaps, peculiar to the method of Mr. Byrom, where beauty, brevity, and legibility, are happily combined.

The twenty-one consonants which compose the short-hand alphabet are formed out of simple lines, to some of which are attached small loops or twirls. These lines derive their respective powers and properties by their difference of position, and by some of them being made curvilineal.

The horizontal characters are always to be written from left to right; the perpendicular ones are invariably written downwards; and with respect to the oblique characters, it is to be observed, that those which lean to the left are generally written upwards, while those having their inclination to the right hand are always written downwards. Not any of the twirled letters (the duplicate characters denoting *h*, *j*, *w*, and *sh*, which are never joined to any other letters, but simply stand for the words *had*, *just*, *would*, and *should*, excepted) ought never to be written so as to end with the loop. This observation must not be forgotten by the learner, and he will never be at a loss about the manner of joining the looped characters to other letters.

It will be observed that some of the letters are denoted by two, and the letter *l* even by three different characters; but as these characters are formed in the same manner, having only a simple change of position, and as they will be found to be of singular advantage in the joining of them to some letters, no ambiguity can possibly arise by their occasional use. The little mark, denoting the abbreviation for the two Latin words *et cetera*, is formed out of the letters *t* and *s*, and is well calculated for the purpose to which it is applied. It is the only character (if we except the little mark for the very common termination o *ing*) which has the apparance of an arbitrary mark in the whole system;

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and even this is formed not strictly upon an arbitrary but an alphabetical principle.

We have already observed that the vowels are expressed in short-hand by means of dots, distinguished by their relative situations with respect to the consonants to which they are supposed to be joined. Although it is proper, in the spelling of words, to use no more vowels than are strictly necessary to convey the sound: yet as all writing must be rendered extremely illegible by their total omission in the middle of words, we will here lay down proper directions for their use and application. Whenever a vowel constitutes a perfect syllable in any word, whether that syllable be incipient, radical, or terminative, it must always be inserted, unless in the case of following a very rapid speaker; and the vowels which are then unavoidably omitted should be inserted as soon as convenient afterwards, while the subject is fresh in the writer's memory; by which means the legibility of the writing will be effectually secured and preserved.

The manner of placing the vowels in this system is, of all others, the most natural, and the freest from ambiguity. A simple stroke, however placed, will naturally suggest the idea of supplying five different places for the five vowel points: *viz.* the top, the middle, the bottom; and the centres of the halves, when so divided. Care, however, must be taken not to place the dot for the vowel *a*, *over* the perpendicular or oblique characters; nor the same vowel point *before* the horizontal ones. By a very slight attention it will be observed, that in this plan of short writing the same general method is to be observed as in common writing; *i. e.* not to write perpendicular letters from the bottom upwards, nor any letters from the right to the left; consequently all the vowel points belonging to upright consonants are to be placed immediately *before* or *after* the consonant, as the case may require; those connected with the horizontal characters exactly *over*, when they precede, and *under*, when they follow the consonant.

The vowels are always reckoned from the beginning of the consonant. When, therefore, any inclined consonant is begun at the bottom of the short-hand line, and written upwards, the vowels are always counted from the bottom, on each side of the character, upwards. A due attention to the manner of placing the vowel points, in the cases of curved or semicircular letters, as it is exhibited in the annexed plate, will explain the matter, beyond the possibility of misconception or embarrassment. With respect to the long and short sounds of vowels, it is convenient, when time will allow of it, to express the broad sound of a vowel by making its representative dot a little larger than in the usual method of expressing the vowels. When two, or more, different vowels occur, without any intervening consonant, they may be distinguished by making the first a little thicker and stronger, diminishing their respective strengths until the last vowel is expressed, by being made of the usual thickness. Two *e s*, or two *o s*, may be expressed by two dots of the same size. In swift writing, we know, these minutiæ cannot always be strictly attended to. It is, nevertheless, convenient to have a method so simple and useful to resort to, when time will allow; and it is one of the many excellencies peculiar to this system, that it will admit of these orthographical attentions.

The letter *y*, at the beginning of words, is a consonant; but at the end of words, or when it follows a consonant, it is a vowel, and, as such, is represented, in short-hand, by a dot in the *i's* place, as in the word *buti*, *beauty*.

As the horizontal characters may be written at the top, or middle, or bottom, of the line, the vowels may be sometimes *indicated* by their situation between the parallels, as *same*, at the top: *sin*, in the middle; and *sun*, at the bottom of the line.

There are few monosyllables, beginning with a vowel, that are immediately followed with either *h* or *w*; for which reason the following rule, peculiar to these two letters, will seldom occasion any ambiguity, and affords a convenient method of expressing a great variety of very common words. The letters *h* and *w*, having a vowel point before them, are to be considered as denoting, by one mark, the two letters, *hi*, *wi*, respectively, with the prefixed vowel between them; as in the words, *hat*, *hit*, *hot*, *hut*; *wat*, *wet*, *wit*, *wot*, &c.

Having said thus much concerning the nature and use of the vowel points, we will proceed to give some further directions relative to the form and proportion of the short-hand characters; the various ways of joining the curvilineal ones with the greatest ease and elegance; together with some rules, designed to obviate a few apparent difficulties which may be supposed to occur, more or less, to every learner of short-hand.

1. All the perpendicular and inclined letters are made to touch, as it were, two

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imaginary parallel lines, whose distance is supposed to be adjusted by the length of the short-hand *t*, ⊤ It is sometimes necessary, in order to preserve a perfect lineality in the writing, to make these letters only half their usual size; as in the words *foot*, *form*, *gold*, &c. In a very few instances, where lineality cannot be preserved, even by thus curtailing the size of the letters, it is always best to lift the pen, and write the word at twice, taking care to place the detached parts very near to each other, to denote their connection. Instances of this kind occur so very seldom in practice, that no perceptible difference will be experienced in the brevity of writing, while a very material advantage will be gained on the score of beauty and legibility; considerations never to be lost sight of by the lovers of useful and rational stenography.

2. The diameter of the horizontal semicircular letters is the short hand — *s*; and their height is rather more than one third part of the letter | *t*.

3. As both the *beauty* and the *brevity* of short-hand writing depend very much on avoiding, as much as possible, the making of angles, and on the general uniformity of the writing, it is proper, in joining such letters as *m* and *n*, *m* and *f*, *m* and *p*, &c. together, to deviate a little from the correct form of each letter: so that they may readily and naturally run into each other. The learner will easily discern where it is necessary to preserve the precise point of concurrence, as in the case of *md*, *hb*.

4. The letter | *t* is occasionally used for *th*, writing the adjoining letter only half its usual size; as in *thr*, *thm*, &c.

5. Except in the foregoing case, a letter of half size, when it is made *optionally*, always indicates that the adjoining character is to be resolved into two letters. When it is requisite to double the letters *r* or *f*, and no consonant is required to be joined with them, they are generally lengthened by a greater inclination of the stroke than usual. Double *t*, and double *s*, when necessary, may be made by a little break in the middle, which may be done, without taking off the pen, by only a very slight movement of it from the line it was describing. There are one or two cases, where it is better entirely to lift the pen, and make a small stroke through the letter, nearly in the manner we usually cross the *t* in long hand. This expedient is requisite in writing the words *idler*, *butler*, *miller*, &c.

6. No letters are to be doubled in short-hand unless some vowel comes between them.

7. When there are various ways of joining the same letters together, which, in the present highly improved system of short-hand, is not unfrequently the case, the learner should accustom himself to that which is the best, or most lineal, preserving as much as possible the full proportion and compact form of every letter.

It is to be observed, as another advantage peculiar to this system, that here the strictest adherence to the common rules of punctuation may be observed. The period, or full stop, which is supplied by a very small circle, ₀ being the only exception.

The characters denoting the prepositions and terminations being derived from the alphabet, are easily retained in the memory, and are of very extensive use to the brevity and legibility of short-hand. Their respective powers and uses are distinctly delineated in the plate. It is sufficient to remark, that, in writing them, they ought always to be formed rather smaller than the rest of the letters, and should be placed sufficiently near the radical part of the word of which they constitute a part, that they may not be mistaken for separate and distinct words. Double prepositional characters joined together, as *compre-*, *misunder-*, &c.

The plural of nouns, ending in *s*, ought to have their terminative letter written rather smaller than the other letters. A very little practice will accustom the writer to this method of denoting such plural nouns.

When the learner has acquired a perfect knowledge of so much of the art as we have already laid down, he may proceed to make himself acquainted with the following

RULES OF ABBREVIATION; by which he will be enabled to follow the most rapid speaker, and will soon become an expert stenographer.

1. The auxiliary verbs, the participle *not*, and the pronouns, being severally denoted by their first consonant, may be joined to one another; as *can be*, *will be*, *have not been*.

2. Join the marks or letters in an unusual manner, in order to show that each

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particular mark denotes a word, and not a single letter; as by joining the letter *n* to the middle instead of the top of the letter *t*, the whole charater , will represent the words *in the;* so, also, the letter *s*, joined to the letter *t*, and drawn from the middle of the preceding consonant, thus , will denote the two words *it is*, or , *it was*. This rule is very comprehensive. The writer will apply it as he finds it necessary or convenient so to do.

3. Derivative nouns, adjectives, and adverbs, may be very conveniently expressed by points, differently placed, at the end of their last consonant. The substantive point being placed immediately following the consonant, and in a direct line with it; the adjective to have its point placed also a little lower down to the left of the substantive point; and the proverb point to be placed, in the same manner, to the right of the substantive point; as, , *forgetfulness;* , *forgetful;* , *forgetfully*.

4. Very common words, or such as have an immediate relation to the subject, and are therefore easily discoverable, may be denoted by their first consonant, or first vowel and consonant, with the substantive, adjective, or adverb point annexed. The adjectives, which usually accompany such substantives, may also be denoted by their first consonant, joined to the substantive; as , *humble servant;* , *human nature;* , *christian religion*, &c.

5. Place a dot at the point of concurrence of two consonant marks, to denote two substantives connected together by some preposition, which is omitted; as , *love of God*, or *light of the gospel;* , *cause of gravity*, &c. Also, when an adjective precedes either of the substantives, they may all three be represented by their first consonants joined together, with the dot placed at the end of the first substantive; as the , *great goodness of God*.

6. The substantive point, placed before a single consonant mark, denotes that the substantive is to be repeated, with some intervening preposition; as, , *day after day;* , from *time to time*, &c.

7. Place the substantive, adjective, or adverb point before two or more consonant marks, to denote two or more substantives, adjectives, or adverbs, connected by a conjunction; as, , *King, Lords*, and *Commons;* , *soberly, righteously*, and *godly*, &c.

8. Express long words by their first syllables, with as many points annexed as there are syllables wanting. In very common words the points may be occasionally omitted.

9. Express long words by their prepositions, together with their next vowel or consonant only.

10. Words may be denoted by their first vowel and consonant, with their terminutions added; as, , *arbitrary;* , *opportunity*, &c

11 Words easily discovered by their connection may be expressed by their first vowel and consonant, or by their prepositions only; and as few English words end with the syllable *to*, the preposition *to* may be joined to the preceding word; as, , *belongs to;* , *satisfactory to*, &c.

12 Join the pronouns to prepositions; as, , *to me;* , *to us;* , *to you*, &c. always adding the vowel point, when the words would otherwise be liable to be mistaken.

13. Join the preceding word, the preposition, and pronoun, all together; as, , *belongs to me;* , *agreed with me*, &c.

14. Join adverbs, verbs, prepositions, pronominal adjectives, and substantives, all together; as, , *safely depend upon my word*, &c.

15. Many common phrases, formed by a substantive, preceded by the prepositions *with, without, in*, &c. and followed by *to, of* &c. may be abbreviated; as, , *with regard to;* , *in consequence of*, &c. These several words are expressed by their first consonants only, joined together the vowel *o* being added in the first example to denote the preposition *to*.

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16. In like manner, denote common adverbial phrases by the initial consonants joined together; as, , *in like manner;* , *in particular;* , *in a great measure*, &c.

17. Numerous contractions may be made, when *it is*, or *it was*, are followed by an adjective, and *to*, or *that*; as, *it is impossible to;* , *it is not to be supposed that*, &c.

The above abbreviating rules, though few in number, are very extensive in their application. An assiduous attention to the nature and idiom of our language, may suggest others as useful and extensive as these. Proper care being taken to lay a right foundation, the legitimate ways of contracting will increase in proportion to the writer's want of them. It must be obvious to every one, how much a systematic plan of abbreviation, like this, is superior to that which consists of a multitude of arbitrary marks to signify particular words and phrases; a plan which not only disfigures the writing, but renders it nearly, if not entirely, illegible even to the writer himself, unless it is transcribed into long hand while the subject is fresh in his memory. The experience of the late ingenious Dr Darwin will serve to illustrate the futility of these systems. "The book I learned short-hand from," says this elegant writer, "was published by Gurney, and said to be an improvement on Mason; other treatises of short-hand I have also examined, and found them all of nearly equal excellence. I can only add, that many volumes I wrote from medical lectures I now find difficult to decipher." Had Dr. Darwin practised the system of Mr. Byrom, we can assert, both from our own experience, and the experience of many others, that he would have found no serious difficulty in deciphering his medical lectures at any period of time after they were written. For, as the present indefatigable Dr. Mavor observes, in the introduction to his own treatise on stenography, "it must be owned that it is above the reach of human ingenuity to exceed his (Mr. Byrom's) general plan, which must for ever be the basis of every future rational system."

The first Part of the Specimens without Contractions, spelt according to the Method used in writing Short-hand. (See Plates Short-hand.)

THE BEAR. A FABLE.

A bear, wo ws bred in the savg desrts of Sibria, had an inklnation to see the wrld. He travld frm forst to forst, and frm on kngdm to anthr, making mni prfnd obsrvations in hs wa. Among the rst of hs exkrsns, he km bi aksdnt into a farmr's yard, wr he saw a nmbr of pltri standing to drnk bi the sid of a pool. Obsrving that at everi sip they turnd up thr heds tords the ski, he could nt frber enkring the resn of so pekulr a srmni. They told hm that it ws bi wy of rtrning thanks to hvn fr the bnfts they rsvd, and ws indd an ansnt and rlgs kstm, which they could nt, with a saf knsns, or wthot impiity, omit. Her the bear brst into a ft of laftr, at ons mimking thr gestrs, and rdkling thr superstition, in the mst kntmtos mnr. On this the kok, with a sprt sutable to the bldness of hs krktr, adrsd hm in the foloing wrds: "As you ar a strngr, sr, you prps ma be exksd the indsnsi of this behvr; yet gv me leav to tl you, that non but a bear would rdkl ani flgs srmni whatsoever, in the prsns of thos wo bliev thm of imprtns."

An Exemplification of the Specimen with Contractions; containing numerical References to all the Rules of Abbreviation, the fourteenth, fifteenth, and seventeenth excepted.

A bear, who was bred IN THE[2] savage
A ber, wo ws bred nt svg

deserts of Siberia, had an INCLINATION[4] to
dsrts of Sbria, had an in. to

see the WORLD[4]. He travelled from
see the W. He trvld frm

FOREST TO FOREST[6], and from one
f. and frm on

KINGDOM[3] to another, making many
kng. to anthr, mking mni

profound OBSERVATIONS[11] IN HIS[12] way.
prfnd obs nis wa.

Among the rest of HIS[12] EXCURSIONS[9], he
Among the rst fis exk. he

came by ACCIDENT[4] into a farmer's yard,
km bi ak. into a frmr's yrd,

where he saw a number of poultry standing
wr he saw a nmbr of pltri stnding

to drink by the SIDE OF A POOL[5]. Observing
to drnk bi the sp. Observing,

that at every sip they turned up their
that at evri sp they trnd up thr

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HEADS[4] towards the sky, HE COULD NOT[1]
hs. trds the ski, kkn

forbear enquiring the reason of so peculiar
frbr enqring the rsn of so pklr

a ceremony. They told him, that IT WAS[2]
a srmni. They tld hm, that ts

by way of returning thanks to HEAVEN[4] for
bi way of rtrning thnks to H. fr

the benefits they received, and was indeed
the bnfts they rsvd, and ws indd

an ANCIENT AND RELIGIOUS[7] custom, which
an nr kstm, which

they could not, with a safe conscience, or
they could nt, wth a saf knsne, or

without IMPIETY[10], omit. Here the bear
wtht impity, mit. Hr the ber

burst into a FIT OF LAUGHTER[5], at once
brst into a ft at ons

mimicking their gestures, and ridiculing
mmking thr gstrs, and rdkling

their SUPERSTITION[9] IN THE[2] most
thr superst. nt mst

CONTEMPTUOUS MANNER[4]. ON THIS[12], the
cm. Onis, the

cock, with a spirit SUITABLE TO[11] the
kk, wth a sprt ste the

BOLDNESS OF HIS[13] character, addressed
bfs krktr, adrsd

him IN THE[2] FOLLOWING[10] words. 'As you
hm nt foing wrds. 'As you

are a stranger, sir, you PERHAPS[3] MAY BE[1]
ar a strngr, sr, you p. mb

excused the INDECENCY[4] OF THIS[12]
xksd the ind. fs

BEHAVIOUR[9]; yet GIVE ME LEAVE TO[16] tell
beh. yt gmlto tl

you, that none but a bear would ridicule
you, that nn but a ber would rdkl.

any RELIGIOUS CEREMONY[4] whatsoever,
uni rs. watsoever.

IN THE[2] presence OF THOSE[12] who believe
nt prsns fos wo blv

them of importance.'
thm of imprtns.'

The learner will perceive, by this exemplification of the short specimen on the Plate, that the rules of abbreviation are not only constructed on the most simple and scientific principles, but that they possess an almost unlimited power of contraction, and have a peculiar adaptation to the genius and phraseology of our language. With these rules, perfectly learnt, and brought into use by experience, the present system of short-hand may be applied to all the purposes for which this invaluable art is intended, with as little labour in the acquisition, and with less ambiguity in decyphering, than attends the learning of any other system of stenography hitherto made public.

Having availed ourselves of the improvements make by Mr. Molineux on this mode of short-writing, first invented by Mr. Byrom, and recommending the learner for further instructions to Mr. Molineux's treatise, we think it only necessary, in order to give the learner a still more adequate knowledge of this system of short-hand, to lay before him the following

GENERAL DIRECTIONS FOR A YOUNG STENOGRAPHER.

1. Short-hand is one of the perpendicular hands; and that your writing may have a vertical appearance, always place yourself exactly parallel with your paper.

2. Make all your strokes of an equal thickness; and endeavour to be as correct as possible in the formation of the short-hand characters; because any material deviation, either in their shape, or in the position of the stroke, may express a different letter, or produce illegibility.

3. Let the looped or twirled letters have their loops made as circular as is consistent with beauty and ease of joining.

4. Make the horizontal characters, which denote the letters *m* and *n*, with their derivatives, *ch* and *g*, nearly semicircular; but the rest of the curvilineal letters, which are either vertical or oblique, are always less curved, except when they are made only half size.

5. Spell in the shortest but neatest and most compact manner possible.

6. Use no more vowels than are necessary; yet never leave out any that are distinctly sounded.

7. Observe lineality and beauty at all times, and occasionally lift your pen, rather than fall below or rise above the space allotted for the short-hand characters.

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8. Use no arbitrary marks at all: but let every abbreviation be formed upon rational and scientific principles.

9. Never use the common stops or points for any but their own proper and legitimate purpose.

10. Never affect too much brevity: common short-hand is short enough for all common purposes.

11. Make no fanciful innovations in the art: but let all your improvements be founded on the rational principles laid down by the ingenious inventor.

12. If you write Byrom's Short-hand, your writing will be easily read by all who practise the same system. Let all rational stenographers observe uniformity, and the art will soon become generally useful.

13. Write not too close; and never suffer your characters to have a weak, diminutive appearance. Let your whole practice be bold and dignified; agreeably to the genius of the system you have adopted.

14. Do not make a secret of the art: it is worthy of being universally known and practised.

SHORT *sightedness*, in medicine. See MYOPIA.

SHOT, a denomination given to all sorts of balls for fire-arms; those for cannon being of iron, and those for guns, pistols, &c. of lead.

"To find the weight of an iron shot," whose diameter is given; and the contrary. Rule. Double the cube of the diameter in inches, and multiply it by 7; so will the product (rejecting the two last or right hand figures) be the weight in pounds. Ex. What is the weight of an iron shot of 7 inches diameter? The cube of 7 is 343, which doubled is 686, and this multiplied by 7 produces 4802, which, with the right hand figures rejected, gives 48 pounds, the weight required.

"To find the diameter of the shot," when the weight is given. Rule. Multiply the cube root of the weight in pounds by 1.923, and the product is the diameter in inches. Ex. What is the diameter of an iron shot of 52 pounds? The cube root of 52 is 3.732, which multiplied by 1.923 gives 7.177 inches, the diameter required.

Rule by Logarithms.

To one-third of the logarithm of 52	0.582001
Add the constant logarithm	0.283979
And the sum is the logarithm of the diameter is 7.177 .	0.855980

"To find the diameter of a shot," from the impression or cavity it makes by striking a brass gun, or other object. Rule. Divide the square of the radius of the cavity by the depth of it, and add the quotient to the depth, the sum will be the diameter of the shot required.

SHOT, *common, small*, or that used for fowling, should be well sized: for, should it be too great, then it flies thin and scatters too much: or if too small, then it has not weight and strength to penetrate far, and the bird is apt to fly away with it. In order, therefore, to have it suitable to the occasion, it not being always to be had in every place fit for the purpose, we shall set down the true method of making all sorts and sizes under the name of mould-shot, formerly made after the following process:

Take any quantity of lead you think fit, and melt it down in an iron vessel; and as it melts keep it stirring with an iron ladle, skimming off all impurities whatsoever that may arise at top: when it begins to look of a greenish colour, strew on it as much auripigmentum, or yellow orpiment, finely powdered, as will lie on a shilling, to every twelve or fourteen pounds of lead; then stirring them together, the orpiment will flame. The ladle should have a notch on one side of the brim, for more easily pouring out the lead: the ladle must remain in the melted lead, that its heat may be the same with that of the lead, to prevent inconveniencies, which otherwise might happen, by its being either too hot or too cold; then, to try your lead, drop a little of it into water, and if the drops prove round, then the lead is of a proper heat; if otherwise, and the shot have tails, then add more orpiment, to increase the heat, till it is found sufficient.

Then take a plate of copper, about the size of a trencher, which must be made with a hollowness in the middle, about three inches compass, within which must be bored about 40 holes, according to the size of the shot which you intend to cast: the hollow bottom should be thin; but the thicker the brim, the better it will retain the heat. Place this plate on a frame of iron, over a tube or vessel of water, about four inches from the water, and spread burning coals on the plate, to keep the lead melted upon it: then take some lead, and pour it gently on the coals on the plate, and it will make its way

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through the holes into the water, and form itself into shot; do thus till all your lead is run through the holes of the plate, taking care, by keeping your coals alive, that the lead does not cool, and so stop up the holes.

While you are casting in this manner, another person with another ladle may catch some of the shot, placing the ladle four or five inches underneath the plate in the water, by which means you will see if they are defective, and rectify them. Your chief care is to keep the lead in a just degree of heat, that it shall not be so cold as to stop up the holes in your plate, nor so hot as to cause the shot to crack; to remedy the heat, you must refrain working till it is of a proper coolness; and to remedy the coolness of your lead and plate, you must blow your fire; observing, that the cooler your lead is, the larger will be your shot; as, the hotter it is, the smaller they will be.

After you have done casting, take them out of the water, and dry them over the fire with a gentle heat; stirring them continually, that they do not melt; when dry, you are to separate the great shot from the small, by the help of a sieve made for that purpose, according to their several sizes: But those who would have very large shot, make the lead trickle with a stick out of the ladle into the water, without the plate. If it stops on the plate, and yet the plate is not too cool, give the plate but a little knock, and it will run again; care must be had that none of your implements are greasy, oily, or the like; and when the shot, being separated, are found too large or too small for your purpose, or otherwise imperfect, they will serve again at the next operation.

Shot, *patent milled*, are thus made; sheets of lead, whose thickness corresponds with the size of the shot required, are cut into small pieces, or cubes, of the form of a die. A great quantity of these little cubes are put into a large hollow iron cylinder, which is mounted horizontally, and turned by a winch; when, by their friction against one another, and against the sides of the cylinder, they are rendered perfectly round and very smooth. The other patent-shot are cast in moulds, in the same way as bullets are.

SHRIMP, in ichthyology, the English name of two different species of the squilla, *viz.* the common shrimp, and the smooth-nosed shrimp. See Squilla.

SHROWDS, or Shrouds, in a ship, are the great ropes which come down both sides of the masts, and are fastened below to the chains on the ship's side, and abaft to the top of the mast; being parcelled and served, in order to prevent the mast's galling them. The top-mast-shrowds are fastened to the puttock plates, by dead eyes and lanyards, as the others are. Some of the terms relating to the shrouds are; ease the shrouds, that is, slacken them; and set up the shrouds, that is, set them stiffer.

SHUTTLE, in the manufactures, an instrument much used by weavers, in the middle of which is an eye or cavity, wherein is inclosed the spool with the woof. See Weaving.

SIBBALDIA, in botany, so named in memory of Sir Robert Sibbald, professor of physic at Edinburgh, a genus of the Pentandria Pentagynia class and order. Natural order of Senticosæ. Rosaceæ, Jussieu. Essential character: calyx ten-cleft; petals five, inserted into the calyx; styles from the sides of the germ; seeds five. There are three species.

SIBTHORPIA, in botany, so named in honour of Humphrey Sibthorp, M. D. professor of botany at Oxford, a genus of the Didynamia Angiospermia class and order. Natural order of Pediculares, Jussieu. Essential character: calyx five-parted; corolla five-parted, equal: stamina in remote pairs; capsule compressed, orbicular; two-celled, with the partition transverse. There is only one species, *viz.* S. Europœa, Cornish money-wort, a native of Portugal and England, in shady places; it flowers in July and August.

SICE *ace*, a game with dice and tables, whereat five may play; each having six men, and the last out losing. At this game, they load one another with aces; sixes bear away; and doublets drinks, and throws again.

SICYOS, in botany, a genus of the Monoecia Syngenesia class and order. Natural order of Cucurbitaceæ. Essential character: calyx five-toothed; corolla five-parted; male, filaments three; female, style trifid; drupe one-seeded. There are three species.

SIDA, in botany, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Generic character: calyx perianth, one-leafed, angular; corolla, petals five, wider above, emarginate, fastened below to the tube of the stamens;

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stamina, filaments very many, united below into a tube, in the apex of the tooth, divided; pericarpium, capsule roundish, angular, composed of five or more cells; seeds solitary There are ninety-nine species, natives of warm climates; and most of them are found in the East or West Indies. The Chinese make cords of the S. abutilon. This plant loves water, and may be advantageously planted in marshes and ditches, where nothing else will grow. The maceration of the smaller stalks is finished in about fifteen days; of the larger in a month. The strength and goodness of the thread appears to be in proportion to the perfection of the vegetation, and to the distance that the plant is kept at from other plants. The fibres lie in strata, of which there are sometimes six; they are not quite straight, but preserve an undulating direction, so as to form a net-work in their natural positions. Their smell resembles that of hemp; the fibres are whiter, but more dry and harsh than those of hemp. The harshness is owing to a greenish gluten which connects the fibres; and the white colour must always be obtained at the expense of having this kind of thread less supple; when of its natural hue, it is very soft and flexible.

SIDE, the half of any thing, as an animal, a ship, &c. The sides of an animal are distinguished into the right and left side; but those of a ship, into the starboard and larboard side. In geometry, the sides of a rectilinear figure are the lines which form its periphery.

SIDES *men*, or SYNOD'S *men*, persons who, in large parishes, are appointed to assist the churchwardens, in their inquiry and presentments of such offenders to the ordinary, as are punishable in the spiritual court.

SIDEREAL *day*, is the time in which any star appears to revolve from the meridian to the meridian again; which is 23 hours 56′ 4″ 6‴ of mean solar time; there being 366 sidereal days in a year, or in the time of 365 diurnal revolutions of the sun; that is, exactly, if the equinoctial points were at rest in the heavens. But the equinoctial points go backward, with respect to the stars, at the rate of 50″ of a degree in a Julian year; which causes the stars to have an apparent progressive motion eastward 50″ in that time. And as the sun's mean motion in the ecliptic is only 11 signs 29° 45′ 40″ 15‴ in 365 days, it follows, that at the end of that time he will be 14′ 19″ 45‴ short of that point of the ecliptic from which he set out at the beginning; and the stars will be advanced 50″ of a degree with respect to that point. Consequently, if the sun's centre be on the meridian with any star on any given day of the year, that star will be 14′ 19″ 45‴ + 50″ or 15′ 9″ 45‴ east of the sun's centre, on the 365th day afterward, when the sun's centre is on the meridian; and therefore that star will not come to the meridian on that day till the sun's centre has passed it by 1′ 0″ 38‴ 57⁗ of mean solar time; for the sun takes so much time to go through an arc of 15′ 9″ 45‴; and then, in 365d 0h 1′ 0″ 38‴ 57⁗, the star will have just completed its 366 h revolution to the meridian.

SIDERITE, a name given by Bergman to a supposed peculiar metallic substance, which is the principal cause of the brittleness of some kinds of bar iron. This has long since been discovered as the phosphate of iron.

SIDERITIS, in botany, *iron-wort*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx five-cleft; corolla ringent; upper lip bifid, lower three-parted; stamina within the tube of the corolla; stigma, the shorter involving the other. There are twenty species.

SIDEROXYLON, in botany, *iron-wood*, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Sapotæ, Jussieu. Essential character: corolla five-cleft; nectary five-leaved; stigma simple; berry five-seeded. There are nine species, chiefly natives of the Cape of Good Hope.

SIEGE, in the art of war, the encampment of an army before a fortified place, with a design to take it. The method of encamping is very different in a siege from that observed on a march; as in the former the army environs the place without cannon-shot, that nothing may enter. If the place be situated on a river, a detachment is sent to the other side, and bridges of communication made, both above and below the town. The army also encamp with their backs to the town, with the battalions and squadrons interlined; and having taken possession of all the heights, whence the enemy may be annoyed, the engineers trace the lines of circumvallation and contravallation; every regiment working at the place appointed them. See FORTIFICATION. Captain James, in his Military Dictionary, has given the following rules, which ought to be adopted in sieges. The ap-

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proaches should be made without being seen from the town, either directly, obliquely, or in the flank. No more works should be made than are necessary for approaching the place without being seen; *i. e.* the besiegers should carry on their approaches the shortest way possible, consistent with being covered against the enemy's fire. All the parts of the trenches should mutually support each other; and those which are furthest advanced, should be distant from those that defend them above 120 or 130 toises, that is, within musket-shot. The parallels, or places of arms the most distant from the town, should have a greater extent than those which are the nearest, that the besiegers may be able to take the enemy in flank, should he resolve to attack the nearest parallels. The trench should be opened or begun as near as possible to the place, without exposing the troops too much, in order to accelerate and diminish the operations of the siege. Care should be taken to join the attacks; that is, they should have communications, to the end that they may be able to support each other. Never to advance a work, unless it be well supported; and for this reason, in the interval between the second and third place of arms, the besiegers should make, on both sides of the trenches, smaller places of arms, extending 40 or 50 toises in length, parallel to the others, and constructed in the same manner, which will serve to lodge the soldiers in, who are to protect the works designed to reach the third place of arms. Take care to place the batteries of cannon in the continuation of the faces of the parts attacked, in order to silence their fire; and to the end that the approaches, being protected, may advance with great safety and expedition. For this reason the besiegers should always embrace the whole front attacked, in order to have as much space as is requisite to place the batteries on the produced faces of the works attacked. Do not begin the attack with works that lie close to one another, or with rentrant angles, which would expose the attack to the cross fire of the enemy.

"Stores required for a month's siege are as follow:" powder, as the garrison is more or less strong, 8 or 900,000lb.; shot for battering pieces, 6,000; shot of a lesser sort, 20,000; battering cannon, 80; cannons of a lesser sort, 40; small field-pieces for defending the lines, 20; mortars for throwing shells, 24; mortars for throwing stones, 12; shells for mortars, 15 or 16,000; hand grenades, 40,000; leaden bullets, 180,000; matches in braces, 10,000; flints for muskets, best sort, 100,000; platforms complete for guns, 100; platforms for mortars, 60; spare carriages for guns, 60; spare mortar beds, 60: spare sponges, rammers, and ladles, in sets, 20; tools to work in trenches, 40,000.

Several hand-jacks, gins, sling-carts, travelling forges, and other engines proper to raise and carry heavy burdens; spare timber, and all sorts of miners' tools, mantles, stuffed gabions, fascines, pickets, and gabions.

SIENITE, in mineralogy, one of the compound primitive rocks that consists essentially of crystals and grains of hornblende imbedded in felspar. Quartz and mica are occasionally found in sienite, but in very small quantity. It is commonly in mass, and is rarely either schistose or stratified. It sometimes contains metallic veins

SIEVE, or SEARCE, an instrument serving to separate the fine from the coarse parts of powders, liquors, and the like; or to cleanse pulse from dust, light grains, &c. It is made of a rim of wood, the circle or space whereof is filled with a plexus of silk, tiffany, hair, linen, wire, or even thin slices of wood. The sieves which have large holes, are sometimes also called riddles, such as the coal or lime sieve, the garden sieve, &c. When drugs are apt to evaporate, on being passed through the sieve, it is usual to have it covered with a lid

SIGESBECKIA, in botany, so named from John George Siegesbeck, a German, prefect of the Petersburg garden, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx exterior, five-leaved, proper, spreading; ray halved; pappus none; receptacle chaffy. There are three species.

SIGHT, *sense of.* The organ of sight is a globular body, which contains within it transparent substances, fitted to form on the back part of it a picture of the object of sight. An examination of the eye of an ox will give a pretty accurate idea of the general structure of the human eye. We see in front a horny transparent substance, called the cornea. Next to this is a watery fluid, called the aqueous humour, in which the iris floats like a delicate curtain, with a hole in the middle, called the pupil. Behind the iris we

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find a solid body with two convex surfaces; this is called the crystalline lens. Next to this is the vitreous humour, a jelly like, transparent substance, which fills the ball of the eye. The retina consists of exceedingly minute fibres from the optic nerve, which are spread over the whole of the back part of the inner surface of the eye. Behind the retina is a mucous or slimy matter, which in the human eye is of a dark colour, and serves to imbibe the rays of light which pass through the retina, so as to prevent the confusion which would arise from the reflection of them. The retina is the immediate organ of sight. The rays of light, proceeding from every visible point of the object of sight, enter the eye through the cornea, and pass through the pupil; they are refracted by the three humours of the eye, so as to form upon the retina an exquisitely beautiful and distinct, though minute, picture of the object. A pretty correct idea of the formation of this picture may be obtained, by carefully cutting off the back coating of an ox's eye, and holding behind it a piece of paper to receive the picture of a luminous object. For a more minute occount of the structure of the eye, see ANATOMY.

What effect is produced upon the optic nerve by the formation of this picture upon the retina is not certainly known; it is sufficient for our present purpose, that, by means of the nerve, &c. the impression, whatever it be, is communicated to the mental organs, and produces in them those effects, which, when attended with consciousness, are called sensations. See MENTAL PHILOSOPHY, § 11.

If the sensation produced by the object of sight be considered, unblended with the relics of other sensations, we find that it is merely what can be communicated by a minute picture on the retina. The sensation of colour can be thus communicated, and this is the only sensation which can be considered as appropriate to the sight. The sensation of figure can be thus communicated, but only of figure in two directions, length and breadth: for the picture on the retina can have only those two dimensions. The sensation of magnitude can also be thus communicated, but not of real magnitude; for the visible sensation of real magnitude cannot be conveyed by a picture, which is almost indefinitely smaller than the real object. To use the illustration of Adam Smith: "If you shut one eye, and hold immediately before the other a small circle of plain glass, of not more than half an inch in diameter, you may see through that circle the most extensive prospects, lawns, and woods, and arms of the sea, and distant mountains. You are apt to imagine that the visible picture, which you thus see, is immensely great and extensive; but it can be no greater than the visible circle through which you see it. If, while you are looking through the circle, you could conceive a fairy hand and a fairy pencil to come between your eye and the glass, that pencil might delineate upon that little glass the outline of all those extensive lawns, and woods, and arms of the sea, and distant mountains, in the dimensions with which they are seen by the eye." Again, it is obvious, that however large, or however small, the field of view, the picture occupies an equal extent on the retina. Similar observations may be made with respect to distance. The organ of sight can convey only that sensation of distance which may be produced by a minute picture on the retina; that is, nothing but the sensation of the distances of the different parts of the picture, which may bear no proportion to the real distances, and can only be in one direction. Similar things may be said of motion, that is, change of position. The visible sensation of motion is merely that produced by the motion of different parts of the picture on the retina.

The fact is, that not the objects themselves, but the picture formed upon the retina, is the immediate object of the sight. Without the sense of touch, it is probable that the picture would never have conveyed ideas of real figure, magnitude, motion, or position; still more, that it would never have conveyed the idea that external objects produced the picture. Of colour it does convey sensations, which do not receive correction from the touch, and which can be acquired by the sight alone. Persons completely blind have been known to distinguish objects of one colour from those of another, but this is by the feel of the surfaces of those objects. If they have never at all possessed sight, though they may speak of colours, and distinguish coloured objects, and even have a remote idea of the causes of our sensations of colours, yet, they can have no sensations, nor consequently ideas of colours. Mr. Locke mentions a blind man, who said, that he imagined the colour of scarlet resembled the sound of a trumpet.

The limits here stated of the direct

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power of the sense of sight may appear strange to those who have not been accustomed to distinguish between the sensation, and the perception of which the sensation forms a part. (See SENSATION.) We seem to have an immediate sensation of the real situation and magnitudes, &c. of objects; but what has been before stated is an indisputable fact. The case is, the compound idea, formed from the sensations of touch, in connection with certain visual sensations, are so early formed, and so early connected with those visual sensations, that we have no recollection of the simple idea of sensation, or of the formation of the compound idea; indeed, as active agents, we had no concern in the formation of our perceptions. There are, however, numerous circumstances which prove the point; the most satisfactory are those attending the obtaining of the sight, at a period when recollection can register the sensations. One such case fell under the observation of the able Cheselden, and we shall state some of the principal circumstances of it. Mr. C. couched a youth of thirteen years of age; when he was allowed to use his sight, all objects appeared to him alike to touch his eyes, as the things which he felt touched his skin. He considered solid bodies as planes differently coloured; and when he had learned to distinguish solids by their appearances, he was greatly surprised when examining the pictures of solids, to find all the parts plane and smooth like the rest; he asked which of his senses deceived him, his sight or his hearing? Being shown a miniature of his father, which was painted on a watch case, he at once perceived that it was a representation of his father, but expressed great surprise that so large a countenance could be contained in so small a space: it appeared to him as impossible as for a pint to hold a hogshead. Mr. Ware published, in the Philosophical Transactions of 1800, a case which seemed to militate greatly against Mr. C.'s conclusions; Mr. W.'s patient from the first had ideas of distance and form. But Mr. W. himself furnishes a solution of this difficulty: for we find, from his paper, that his patient had always been able to distinguish light and vivid colours from shade.

Sensations of colour are in the early parts of life very vivid, and assist considerably in the formation of our mental pleasures; but the other sensations derived from this sense are principally important to us, as being by association the signs of the ideas derived from the touch; and from their distinctness well calculated to serve as the connecting bond of union, and to bring again into the view of the mind those ideas. The visual sensations, of themselves considered, are seldom the objects of reflection: we seldom even think of them, and while we appear to give to the visible appearances of objects our minutest attention, we are in part attending only to the tangible qualities of which the visible appearance is the sign. Were it not therefore for association, the sight would be of little more use to us than a beautiful picture of objects with which we have no concern. But consider its value in connection with association, and it must be regarded as the most perfect and the most permanently valuable of all the senses. The information obtained by the touch is acquired slowly; and the sensations must be continually repeated, in order to acquire information respecting new objects; but the sight takes in a vast variety of objects, and, almost at a glance, can distinguish most that is necessary to be known respecting them. Its sensations recall the past impressions derived from the touch, and at once suggest the size, the shape, the distance of their various objects. "If a man," says Reid, "were by feeling to find out the figure of the Peak of Teneriffe, or even of St. Peter's at Rome, it would be the work of a lifetime" Besides, its discovery reaches farther than the touch could carry us; it enables us to range through the vault of Heaven, and determine the motions of the heavenly luminaries. It traces in the countenance the workings of the mind; it displays the passions and affections of the soul. With association it is every thing; without it, it would be useless as the bright fleeting visions of sleep.

SIGHTS *of a quadrant*, &c. thin pieces of brass, raised perpendicularly on its side, or on the index of a theodolite, circumferentor, &c. They have each an aperture, or slit, up the middle, through which the visual rays pass to the eye, and distant objects are seen.

SIGN, in algebra, denotes a symbol or character. Mr. Maclaurin observes, that the use of the negative sign, in algebra, is attended with several consequences that at first sight are admitted with difficulty, and has sometimes given occasion to notions that seem to have no real foundation. This sign implies, that the real value of the quantity represented by the letter to which it is prefixed is to be

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subtracted: and it serves, with the positive sign, to keep in view what elements or parts enter into the composition of quantities, and in what manner, whether as increments or decrements, (that is, whether by addition or subtraction,) which is of the greatest use in this art. See NEGATIVE *sign*.

SIGNS, in astronomy. The ecliptic is usually divided, by astronomers, into 12 parts called signs, each of which, of course contains 30 degrees. They are usually called the signs of the zodiac; and beginning at the equinox, where the Sun intersects and rises above the equator, have these names and marks, Aries ♈, Taurus ♉, Gemini ♊, Cancer ♋, Leo ♌, Virgo ♍, Libra ♎, Scorpio ♏, Sagittarius ♐, Capricornus ♑, Aquarius ♒, Pisces ♓. Of these signs, the first six are called northern, lying on the north side of the equator; the last six are called southern, being situated to the south of the equator. The signs from Capricornus to Gemini are called ascending, the Sun approaching or rising to the north pole while it passes through them; and the signs from Cancer to Sagittarius are called descending, the Sun, as it moves through them, receding or descending from the north pole. See ZODIAC.

SIGN *manual*. The King's signature is so called. All commissions in the regular army of Great Britain, army warrants, &c. bear the sign manual. The appointments of officers in the volunteers have been so distinguished during the present war. Adjutants only in the militia have their commissions signed by the King; those of the field officers, captains and subalterns, &c. are signed by the lords lieutenants of counties, or by their deputies, for the time being, sanctioned by a previous intimation from the Secretary of State, that the King does not disapprove of the names which have been laid before him.

SIGNALS, certain signs agreed upon, for suddenly conveying intelligence to places to which the voice cannot reach. Thus, in some countries, fires are lighted upon the hills, at the approach of danger: and at the beginning of a battle or an attack, signals are usually made with drums and trumpets. At sea they are given by firing cannon, or muskets, by lights, flags, sails, &c.

Signals at sea are made by the admiral or commander in chief of a squadron, either in the day, or by night, whether for sailing, fighting, or the better security of the merchant ships under their convoy; these are very numerous and important, being all appointed and determined by the Lords of the Admiralty, and communicated in the instructions sent to the commander of every ship of the fleet or squadron before their putting to sea. Some of the principal of which are as follow: when a commander in chief would have them unmoor, he looses his main-top-sail, and fires a gun, which, in the royal navy is to be answered by every flag-ship, and every ship is to get under sail as soon as she can. When, in bad weather, he would have them wear, and bring to the other tack, he hoists a pendant on the ensign-staff, and fires a gun: then the leeward-most and sternmost ships are to wear first, and bring on the other tack, and lie-by, or go on with an easy-sail, till he comes ahead. When any ship discovers land, he is to hoist his jack and ensign, and keep it abroad till the admiral answer him by hoisting his, on sight of which he is to hawl down his ensign. If any discovers danger, he is to tack and bear up from it, and to hang his jack abroad from the main-top-mast cross trees, and to fire 2 guns: but if he should strike or stick fast, then, besides the same signal with his jack, he is to keep firing, till he sees all the fleet observe him, and endeavour to avoid the danger. When the admiral would have the vice-admiral to send out ships to chase, he hoists a flag striped white and red on the flag-staff at the fore-top-mast-head, and fires a gun: but if he would have the rear-admiral do so, he hoists the same signal on the flag-staff at the mizen-top-mast-head, and fires a gun. When he would have them give over chase, he hoists a white flag on his flag-staff at the fore-top-mast-head, and fires a gun; which signal is also to be made by that flag-ship which is nearest the ship that gives chase, till the chasing ship sees the signal. When the admiral would have the fleet prepare to anchor, he hoists an ensign, striped red, blue, and white, on the ensign-staff, and fires a gun; and every flag-ship makes the same signal.

Besides these, there are many other signals used by day; and different signals upon these and other occasions, used by night: and others also when a fleet sails in a fog; all of which are to be found in the Book of Signals.

The signals for managing a sea-fight are also very numerous, the principal of which are as follow: when the admiral would have the fleet form a line of battle,

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one ship a-head of another, he hoists an union-flag at the mizen-peak, and fires a gun; and every flag-ship does the like. But when they are to form a line of battle one abreast of another, he hoists a pendant with the union-flag, &c. When he would have the admiral of the white, or he that commands in the second post, to tack, and endeavour to gain the wind of the enemy, he spreads a white flag under the flag at the main-top-mast-head, and fires a gun; and when he would have the admiral of the blue do so, he does the same with the blue flag. If he would have the vice-admiral of the red do so, he spreads a red flag from the cap, on the main-top-mast-head downward on the back-stay; if the vice-admiral of the blue, he spreads a blue flag, and fires a gun; if he would have the rear-admiral of the red do so, he hoists a red flag at the flag-staff at the mizen-top-mast-head; if the rear admiral of the white, a white flag; if the rear-admiral of the blue, a blue flag, and under it a pendant of the same colour, with a gun. If he would have him that commands in the second post of his squadron to make more sail, he hoists a white flag on the ensign-staff; but if he that commands in the third post be to do so, he hoists a blue flag, and fires a gun; and all the flag-ships must make the same signal. Whenever he hoists a red flag on the flag-staff at the fore-top-mast-head, and fires a gun, every ship in the fleet must use their utmost endeavour to engage the enemy in the order prescribed. When he hoists a white flag on his mizen-peak, and fires a gun, all the small frigates of his squadron, that are not of the line of battle, are to come under the stern. If the fleet be sailing by a wind in the line of battle, and the admiral would have them brace their head sails to the mast, he hoists up a yellow flag on the flag-staff, at the mizen-top-mast-head, and fires a gun, which the flag-ships are to answer; and then the ships in the rear are to brace first. After this, if he would have them fall their head-sails, and stand on, he hoists a yellow flag on the flag-staff of the fore-top-mast-head, and fires a gun, which the flag-ship must answer; and then the ships in the van must fall first, and stand on. If, when this signal is made, the red flag at the fore-top-mast-head be abroad, he spreads the yellow flag under the red flag. If the fleets being near one another, the admiral would have all the ships to tack together, the sooner to lie in a posture to engage the enemy, he hoists an union-flag on the flag-staves at the fore and mizen-top-mast-heads, and fires a gun; and all the flag-ships are to do the same. The fleet being in a line of battle, if he would have the ship that leads the van hoist, lower, set, or hawl-up any of his sails, he spreads a yellow flag under that at his main-top-mast-head, and fires a gun; which signal the flag-ships are to answer; and the admiral will hoist, lower, set, or hawl-up the sail, which he would have the ships that lead the van do; which is to be answered by the flag-ships of the fleet.—When the enemies run, and he would have the whole fleet follow them, he makes all the sail he can after them himself, takes down the signal for the line of battle, and fires two guns out of his fore-chase, which the flag-ships answer: and then every ship is to endeavour to came up with, and board the enemy. When he would have the chase given over, he hoists a white flag at the fore-top-mast-head, and fires a gun. If he would have the red squadron draw into a line of battle, one abreast of another, he puts a broad flag, striped red and white, on the flag-staff at the main-top-mast-head, with a pendant under it, and fires a gun; if the white or second squadron is to do so, the flag is striped red, white, and blue; if the blue or third squadron is to do so, the flag is a Genoese ensign and pendant; but if they are to draw into a line of battle one a-head of another, the same signals are made without a pendant. If they are to draw into the line of battle one astern of another, with a large wind, and he would have the leaders go with their starboard-tacks aboard the wind, he hoists a red and white flag at the mizen-peak, and fires a gun; but if they should go by the larboard-tacks aboard the wind, he hoists a Genoese flag at the same place; which signals, like others, must be answered by the flag-ships.

Signals, *day*, are usually made by flags and pendants, sometimes accompanied with one or more guns; and night-signals are either lanterns disposed in certain figures, as lines, squares, and triangles, or are made with false fires. Fog-signals consist of operations which emit sound, as firing cannon or musquets, beating drums, &c.

Signals, in military actions. In former times large pieces of wood were hung above the towers of cities or castles, which, by being drawn up or lowered, gave intelligence of what passed. This method has been succeeded by the invention of telegraphs, which answer every

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purpose of communication, when they can be established through any extent of country. Besides those signals, there are others which may be called vocal and demi-vocal. The vocal signals are those of the human voice, which consist in the necessary precautions that are adopted to prevent a guard or post from being surprised, to enounce words of command in action, &c. Of the first description are paroles and counter-signs which are exchanged between those to whom they are entrusted, and which are frequently altered during the day and night, to prevent the enemy from receiving any information by means of spies. The demi-vocal signals are conveyed by military instruments; the different soundings of which indicate, instantaneously, whether an army is to halt or advance, whether troops are to continue in the pursuit of an enemy, or to retreat.

The demi-vocal signals, directed to be observed in the British service, as far as regards the manœuvring of corps, &c. consist of signals for the government of light infantry, and of cavalry regiments, squadrons or troops: the latter are properly called soundings. Light infantry signals are to give notice to advance, to retreat, to halt, to cease firing, to assemble, or call in all parties. In the regulations printed by authority it is observed, that these signals are to be always considered as fixed and determined ones, and are never to be changed. The bugle horn of each company is to make himself perfect master of them. All signals are to be repeated; and all those signals, which are made from the line or column, are to convey the intention of the commanding officer of the line to the officer commanding the light infantry, who will communicate them to the several companies or detachments, either by word or signal.

SIGNATURE, in printing, is a letter put at the bottom of the first page, at least, in each sheet, as a direction to the binder, in folding, gathering, and collating them. The signatures consist of the capital letters of the alphabet, which change in every sheet: if there be more sheets than letters in the alphabet, to the capital letter is added a small one of the same sort, as A a, B b; which are repeated as often as necessary. In large volumes it is usual to distinguish the number of alphabets, after the first two, by placing a figure before the signature, as 3 B, 4 B, &c.

SIGNET, one of the king's seals, made use of in sealing his private letters, and all grants that pass by bill signed under his majesty's hand: it is always in the custody of the secretaries of state.

SILENE, in botany, *catch-fly*, a genus of the Decandria Trigynia class and order. Natural order of Caryophyllei. Caryophyllex, Jussieu. Essential character: calyx ventricose; petals five, with claws, crowned at the throat; capsules three-celled. There are sixty-six species.

SILICA, in mineralogy and chemistry, is generally found in a stony state, and, from its forming nearly the entire composition of flint, it has acquired the name of silica, silex, or silicious earth. This earth exists in great abundance in nature, and it constitutes the basis of some of the hardest stones of which the nucleus of the globe consists; and, on account of its great abundance, it has been regarded as the primitive or elementary earth, the base of all the other earths.

Silica forms one of the constituent parts of most stony bodies; but it exists in greatest abundance in agates, jasper-flints, quartz, and rock crystal: in the latter it exists nearly in a state of purity. To obtain it perfectly pure, a quantity of quartz, or rock crystal, may be exposed to a red heat. When it is taken from the fire, and while it is yet hot, it is suddenly immersed in cold water. It is then to be reduced to powder, and if transparent rock crystal has been employed, it is then in a state of tolerable purity. To have it perfectly pure, mix one part of the pounded stone with three parts of potash, and expose them in a crucible to a heat which is sufficient for the fusion of the mixture. The mass thus obtained is soluble in water. Add a sufficient quantity of water for its solution, and drop in muriatic acid as long as there is any precipitate. Let this be repeatedly washed with water and dried. The substance thus obtained is pure silica. It is in the form of very fine white powder, which has neither taste nor smell. The particles are rough and harsh to the feel, as when they are rubbed between the fingers, or touched with the tongue. The specific gravity is 2.6. Light has no action on silica, and it is one of the peculiar characters of this earth, that it resists, unchanged, the greatest degree of heat. There is no action between silica and oxygen azote, or hydrogen; nor is it changed by exposure to the air. It is not acted upon by carbon, phosphorus, or sulphur. It is insoluble in water; but, in a state of minute division, it absorbs a considerable portion, and forms with this liquid a transparent jelly. When it is

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exposed to the air, the whole of the moisture is evaporated.

Silica is frequently found in nature in the crystallized form, and then it is distinguished by the name of rock crystal. It is most commonly in hexagonal prisms, terminated by hexagonal pyramids. Crystals of silica have also been formed artificially. In a solution of silica in fluoric acid, which had remained at rest for two years, Bergman found crystals, some of which were cubes, and some had truncated angles, at the bottom of the vessel. Crystals of silica have also been formed, by diluting largely with water the combination of silica and potash, and allowing it to remain for a long time.

Silica is only acted on by a very few of the acids. These are the phosphoric and boracic, which combine with it by fusion, and the fluoric, which dissolves silica either in the gaseous or liquid state. When silica is held in solution in water by means of an alkali, it is also dissolved by the muriatic acid. The alkalies have a very powerful action on this earth. In the preparation of the pure earth, it was combined with potash by means of fusion. This compound is different in its nature and properties, according to the proportions of the silica and the alkali. Two or three parts of potash, with one of silica, form a compound which is deliquescent in the air, and soluble in water. This was formerly distinguished by the name liquor silicum, or liquor of flints. It is now called silicated alkali. When this solution is long exposed to the air, the earth is deposited in a flaky gelatinous form. It is decomposed by acids, which combine with the alkali, and the pure earth falls to the bottom in the state of fine powder. When the solution is largely diluted with water, and if a greater quantity of the acid be added than is sufficient to saturate the alkali, the silica remains in solution. This is particularly the case when the muriatic acid is employed; but when the silica is in greater proportion, a compound is formed which is possessed of very different properties. The substance thus obtained is glass. This earth also enters into combination with some of the earths. If to a solution of the liquor of flints lime-water be added, a precipitate is formed, which is found to be a compound of silica and lime. Silica also combines with lime by means of heat, and in certain proportions a glass is formed. Silicious earth enters with difficulty into combination with magnesia; but if equal parts of silica and magnesia be exposed to very strong heat, they melt into a white enamel. But the most important compounds of the earths are those of silica and alumina. These earths may be combined together, as appears from the experiments of Guyton, in the humid way. He mixed together equal parts of alumina, dissolved by means of potash, and of silica held in solution by the same alkali. When the solutions came into contact, a brown zone was immediately formed, which spread, by agitation, through the whole mass, and communicated to it a yellowish colour. The mixture was no further changed during the space of an hour, although it was occasionally stirred with a glass rod; but at the end of that time the whole mass assumed the appearance of a thick, opaque, white jelly. When the silica and alumina are mixed together, and formed into a paste with water, and exposed to heat, they strongly cohere, and assume a considerable degree of hardness. This compound forms the basis of all kinds of pottery and porcelain.

Barytes and strontian in some degree dissolve silica as the alkalies do. Two hundred parts of strontian, with sixty of silica, heated intensely in a crucible for an hour, produced a grey sonorous rifty mass, with only a slight caustic taste. This, being boiled in water, was partly dissolved, but could not be crystallized. Saturated with nitric acid, it gave, by evaporation, a copious jelly, which was pure silex. A similar result was obtained when barytes was used instead of strontian.

SILIQUA, in botany, a species of pod, in which the seeds are alternately fixed to either suture or joining of the valves; in this it differs from the legumen, which has its seeds attached to one suture only. This kind of seed-vessel is found in all the class Tetradynamia of Linnæus. See LEGUMEN.

SILIQUOSÆ, in botany, the name of the thirty-ninth order in Linnæus's Fragments of a Natural Method, consisting of plants that have a siliqua for a seed-vessel. It is divided into two sections: 1. Those which have cross-shaped flowers with long pods, as the brassica, cabbages, raphanus, radish, sinapis, mustard, &c. 2. Those with cross-shaped flowers with short rounds pods, as the iberis, candytuft. This order chiefly furnishes biennial and perennial herbs of an irregular figure. The roots are long, branched, crooked, and fibrous; those of the turnip and radish are succulent and fleshy; the flowers are hermaphrodite, and in the

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greater number disposed in a spike at the extremity of the branches. They are easily rendered double by culture. The stamina are six in number, two of which are of the length of the calyx, and the remaining four somewhat longer, but shorter than the petals. The seed-vessel, as we have observed, is a long pod in plants of the first section; a short and round one in those of the second. The seeds are roundish, small, and attached alternately by a slender thread to both sutures, or joining of the valves.

SILK, the web or envelopement of the caterpillar, of a species of moth called the Phalena mori; which, being convertible to various purposes of utility and elegance, forms an important article in commerce, as the material of a valuable manufacture. The caterpillar, or silk-worm, when full grown, encloses itself in a loose web, in the midst of which it forms a much closer case or covering, of an oval form, and varying in colour from white to a deep orange, but usually of a bright yellow colour. In this case, or ball, the animal becomes a chrysalis, and remains enclosed about fifteen days; when, having resumed active life, in the form of a moth, it makes a hole at one end of its prison and comes out. This, as it destroys the silk ball, is prevented, in those countries where silk is cultivated, by killing the chrysalis by means of heat. See PHALENA.

The silk-worm is supposed to be a native of China, at least the Chinese were the first nation in the world acquainted with the manufacture of silk. It was little known in Europe before the time of Augustus. Galen, who lived about the year 160, mentions silk as in use no where but at Rome, and only among the rich. The Emperor Heliogabalus, who died in the year 220, is said to have been the first man that wore a holosericum, or dress made wholly of silk; princes, as well as subjects of the greatest quality, wearing only a stuff made of silk mixed with other materials. In the time of Aurelian, silk was sold in Rome for its weight in gold, and long continued to bear a great value, from the expense attending the mode in which it was procured. The only silk then known was that of China, which was brought from thence, in the raw state, to Berytus and Tyre, in Phœnicia, where it was manufactured; but this branch of commerce being interrupted by the conquests of the Scythians, the Emperor Justinian became desirous of establishing the culture of silk within his dominions; for which purpose he employed two monks, who had been in India, to procure the eggs of the insect from China. This was accomplished about the year 555; the eggs were hatched at Constantinople, and the breed of the insect being carefully encouraged, raw silk was soon produced in abundance, which was worked up into manufactures at Athens, Thebes, Corinth, and other places. It appears, however, that for many years after the establishment of the culture of silk in Greece, garments of this material continued to be very highly valued; as, about the year 790, Charlemagne sent two silken vests as a present to Offa, king of Mercia. About the year 1130, the silk manufacture had made such progress in the island of Sicily as to excite the jealousy of the Venetians, from its interfering with their importations of silks from Greece.—From Venice and Sicily the silk manufacture spread through Italy, from whence it was introduced into the southern provinces of France.

As soon as the worms have produced their balls, or cocoons, they become an article of trade, for in those countries where silk is cultivated few persons reel off their cocoons, but sell them to others, who make this operation a separate business. The silk, as formed by the worm, is so very fine, that if each ball, or cocoon was reeled separately, it would be totally unfit for the purposes of the manufacturer; in the reeling, therefore, the ends of several cocoons are joined and reeled together out of warm water, which, softening their natural gum, makes them stick together, so as to form one strong smooth thread. As often as the thread of any single cocoon breaks, or comes to an end, its place is supplied by a new one, so that, by continually keeping up the same number, the united thread may be wound to any length: the single threads of the newly added cocoons, are not joined by any tie, but simply laid on the main thread, to which they adhere by their gum; and their ends are so fine as not to occasion the least perceptible unevenness in the place where they are laid on. The apparatus for reeling consists merely of a small open kettle of water, under which is a fire to keep it hot, and a reel of a very simple construction. Care should be taken in the operation, that the silk when reeled off may consist of a smooth thread, of equal thickness and strength, not flat, but of a round form, having the small

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threads of which it is composed as equally stretched and firmly united as possible; and that the several rounds, as they lie on the reel, should not be glued together. When the skein is quite dry, it is taken off the reel, and a tie is made with some of the refuse silk on that part of the skein where it bore upon the bars of the reel, and another tie on the opposite part of the skein; after which it is doubled into a hank, and usually tied round near each extremity, when it is laid by for use, or sale. In this state, in which all the silk that is brought from India, and a considerable part of what comes from Italy and other parts, arrives, it is called raw silk; the principal part of it is afterwards sent to a mill to be thrown; that is, to have two ends of it doubled and twisted together, by which it is converted into tram, or organzine, according to the fineness of the silk, and the purposes to which it is intended to be applied in the manufacture. See ORGANZINE.

The culture of silk varies but little in different countries; it does not require any great degree of skill, or a great capital: and as it is well kown that the silk-worm, with proper care, will breed and thrive very well in England, it is not surprising that attempts should have been made to establish the culture of it in this country. The success of Henry the Fourth of France, in extending the culture of silk, which before his time had been confined to a few districts of that kingdom, excited in James the First an active zeal for the introduction of it here. With this view, in 1608, he caused a circular letter of his own writing, to be sent to the Lord Lieutenant of every county, in which he held forth the example of France as affording ground to hope for equal success here. He likewise observed, that from the experience of many private persons, who had bred silk-worms for their pleasure, nothing had appeared to cause a doubt that they may be nourished and reared in England, if provision was made for planting mulberry-trees; and for this purpose the persons to whom the letter was addressed, were directed, at the Quarter Session, or some other public meeting, to persuade and require those of ability to buy and distribute in the county the number of 10,000 mulberry plants, which were to be delivered in London at the rate of three farthings a plant. The King likewise caused printed instructions to be published for planting and propogating the mulberry trees, and for breeding and feeding the worms; and though, at first, most persons were probably averse to such a new undertaking, by the continuance of the royal sanction and support, and the consideration of the great advantages reaped by other European nations from their silk manufactures, many people in the course of a few years, became very earnest for the propogation of the silk-worm, and of the white mulberry-tree for feeding it.

In 1629, Charles the First granted to Lord Aston the keeping of the garden mulberry-trees, and silk-worms, near St. James's; but this royal undertaking soon declined, and the project does not appear to have been renewed, on an extensive scale, till many years after.

In 1718, a patent was granted to John Appletree, Esq. for producing raw silk of the growth of England, and for raising a fund for carrying on the same. The capital of the undertaking was divided into shares of 5*l.* each; a deed of trust was executed and enrolled in Chancery; directors were chosen by the subscribers for managing the affairs of the company: and Chelsea-park being thought a proper soil for the purpose, and in a convenient situation, a lease was taken of it for 122 years. Here upwards of 2000 young mulberry trees were soon planted, and extensive edifices were erected for carrying on the work; this number of trees was however, but a small part of what the company intended to plant, if they were successful.

In 1719, Mr. Henry Barham, who was probably a member of this company, published "An Essay upon the Silk-worm," in which he thinks all objections and difficulties against this "glorious undertaking" are shown to be mere phantoms and trifles; the event, however, proved that the company met with difficulties of a real and formidable nature; for though the expectation of Mr. Barham, who questioned not that in the ensuing year they should produce a considerable quantity of raw silk, may have been partly accomplished, the violent stock-jobbing speculations of that period, which involved the shares of all projects of this nature, must have produced many changes among the proprietors, and deranged the origional design, in consequence of which it soon went to decay. From that time there has been no public undertaking of the kind; but indviduals have continued to rear the silk-worm as an object of curiosity, and have generally

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been successful, as it is easy to bestow a degree of care and attention on a small number, which could not be extended to a large concern. The insurmountable obstacle to raising silk in Great Britain is the climate, which is too cold and wet; and though expedients might be adopted to obviate those inconveniences, they would render the culture of the article on a large scale, by far to expensive.

As the mulberry tree is scarce in some parts of this country, attempts have been made to feed the worms on other plants. Miss Croft of York, in 1792, sent to the Society for the Encouragement of Arts, Manufactures, and Commerce, a specimen of silk produced by worms fed entirely upon lettuce leaves. The respectable society just mentioned, continue to offer premiums for the production of silk in this country; but as all former attempts, made at a time when land and labour were much cheaper than at present, have turned out unprofitable, and consequently been abandoned, there can be little ground for hope that better success would attend future trials.

King James the First, whose zeal for raising silk in this country has been noticed, at the same time extended his views to the Amercan colonies. He several times urged the Virginia Company to promote the cultivation of mulberry trees, and the breeding of silk-worms, particularly by a letter addressed to them, in 1622, expressly on this subject, in which he charged and required them to see that the people there used all possible diligence in breeding of silk-worms, and erecting of silk-works, and that they bestowed their labour in producing this rich and solid commodity in preference to tobacco, an article to which he had a violent aversion. The company appear to have been determined not to be outdone by the King, in zeal for the accomplishment of this object, and accordingly transmitted his Majesty's letter to the Governor and Council of Virginia, with very particular instructions to employ all their endeavours for establishing the staple commodities of silk and wine; for the better accomplishment of which, they sent a number of copies of a book on the subject, written by Mr. John Bonoeil, a member of the company, who engaged earnestly in the attempt, and was so fully convinced of its practicability, that he says, such quantities of silk might easily be made in Virginia, if there were a sufficient number of hands, as in a very short time would serve all Christendom. The misfortunes which the Colony of Virginia experienced, and the dissolution of the company soon after, must have checked the execution of this project very materially; and though a considerable number of trees were planted, and were found to flourish, but little silk appears to have been produced.

In 1654, it appeared that the culture of silk had been revived in Virginia, by Mr. Edward Diggs, who was confident that he had conquered all the principal difficulties respecting this commodity, and made its profit so evident to all the Virginians, that in a short time there would be great quantities of silk made. It does not, however, appear that the culture of silk has since been carried to any considerable extent in Virginia, which is probably owing more to the attachment of the planters to the growth of tobacco, than to any natural impediment.

The settlement of the colony of Georgia was begun in the year 1732, and the trustees, soon after the commencement of their undertaking, caused a common nursery garden to be laid out for white mulberry trees, for the production of silk. It was at this time raised in Carolina, in small quantities, some families making about forty or fifty pounds weight in the year. In order to instruct the colonists of Georgia upon this subject, some persons from Piedmont in Italy, skilled in tending the worms and the winding of silk, were sent thither; and notwithstanding the difficulties attending the attempt, and the public misfortunes of the colony, many persons persevered and experienced some success; an act of parliament was in consequence passed, in 1749, for encouraging the culture of raw silk in the Amercan colonies, by which raw silk, certified to be the real growth and culture of those colonies, was exempted from any duty on importation into the port of London. The culture increased gradually, though slowly, both in Georgia and the adjoining province of South Carolina; but a few years after the produce became more considerable. In the year 1757, 1,052*lbs.* weight of silk balls were received at the filature in Georgia, and the next year produced no less than 7,040*lbs.* weight thereof. In 1759, there were received at Savannah, the capital of Georgia considerably above 10,000*lbs.* weight of raw silk, although it was thought an unfavourable season. As the culture of this

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valuable article thus appeared to be making some progress in the southern colonies, an act of parliament was passed, in 1769, for the further encouragement of the growth of raw silk in America; by which a bounty was granted of 25*l.* for every 100*l.* value of such raw silk for the next seven years, and lesser bounties during the two following periods of seven years. The Society for the Encouragement of Arts, Manufactures, and Commerce, also offered large premiums for encouraging the same object; but still the quantities raised were but small, and the cost too great, for competition with silk from other parts.

There can be no doubt that, in many parts of the southern states of America, the climate is as favourable to the mulberry tree and the silk-worm, as in those countries in Europe where they are raised; the chief difficulty the Americans have to contend with respecting this article is, that in most of the southern states the labourers are Negro slaves, who are not sufficiently attentive and skilful in this business.—In Connecticut, where there is a sensible and careful white population, and where land is comparatively scarce and dear, the culture of silk has been found to be practicable and profitable. A project to extend the white mulberry tree over all the States was formed a few years ago, in consequence of which a considerable number were planted. An extensive nursery of these trees was established near Philadelphia, in 1789; another at Princeton, in New Jersey; and two more in New York and Long Island. The idea upon which these nurseries were principally encouraged was, that they prepared the States for the reception of emigrants from silk countries; but no considerable emigration from those countries has taken place.

In the British settlements in the East Indies, the culture of silk has been long established, particularly in the island of Cossimbwzar and its neighbourhood, in the province of Bengal; and since, about the year 1760, when the company became the rulers of the country, and adopted a new system of trade for the purpose of realizing the surplus revenue, the culture of raw silk has been promoted, and the quantity considerably increased. Of late years, considerable attention has been paid both to the quality of the silk, and to the mode of reeling it, by which it has been very materially improved, so as to rival, in most respects, the produce of Italy.

There are eight principal silk factories belonging to the company in Bengal; and in every filature, or factory, there are employed, according to its size, from three thousand to ten thousand people; and if to these are added the mulberry-planters, worm-feeders, &c. from ten thousand to forty thousand men, women, and children, are attached to each filature. Attempts have been made to introduce the silk-worm in other parts of the company's possessions, especially on the coast of Coromandel. Dr. James Anderson, of Fort St. George, who has been particularly zealous in promoting this among other useful undertakings, introduced mulberry trees at Madras, about the year 1770, and finding they grew luxuriantly, afterwards endeavoured to procure silk-worms' eggs from Bengal; his two first attempts were unsuccessful, but the third in 1789 succeeded, and the advantages likely to accrue from the culture of silk soon engaged several persons on different parts of the coasts in breeding the worms. In a letter to Sir Joseph Banks, dated 26th January, 1792, he says, "I have received accounts of the success of the silk-worms at Palamcotta and Musilapatam, as well as of the recovery of those that had been diseased by the late rains at Tritchinopoly; so that a breed of this insect is already established in an extent of six hundred miles upon the coast; but it will rest with the company to render it productive."

The establishment of the silk manufactory in Great Britain affords one of the most complete instances, in which an art, borrowed entirely from other nations, and employed on a material entirely of foreign growth, has been brought to such perfection in this country, as to equal, and in some instances to surpass, the productions of those countries from which it was derived. The use of silk was introduced into this country gradually, being at first confined to small ornamental articles. In the year 1455 there appears to have been a company of silk-women in England, who most probably only used silk in embroidering and other kinds of needle-work; but their performances at least contributed to bring this elegant material into more general notice. By an act of Henry VIIth, entitled "Silk-work," it appears that, about 1504, the smaller manufactures of silk were executed in England, as it was among other things enacted, that from thenceforth no person should import into England for sale any kind of silk wrought

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by itself, or with any other material, in any place out of the realm, in ribbands, laces, or girdles; but none of the more important branches of the manufacture could then have existed here, or such goods would certainly have been included in the prohibition. The King sometimes obtained a pair of silk stockings, which were brought from Spain, the making of silk hose not having yet been attempted in England; it was, however, introduced about the year 1561, when Queen Elizabeth was presented with a pair of black silk knit stockings, and is said to have been so pleased with them, that she never wore cloth hose after. Elizabeth's fondness of dress must have inclined her to countenance every branch of this manufacture; but little was done for its improvement till the reign of her successor, whose active measures for establishing the culture of silk, and increasing the importance of the manufacture in this country, were by no means fruitless. The broad-silk manufacture was introduced here about the year 1620; and a Mr. Burlamach, a merchant much employed by the King, by his direction, brought from abroad silk throwsters, dyers, and broad weavers; whose assistance so materially contributed to the improvement and increase of the manufacture, that in 1630 it was thought proper to incorporate the silk throwsters of London, and within four miles thereof; and in the following year the silk-men were likewise incorporated: the weavers had been incorporated long before. In addition to these favours from Charles I. he endeavoured to protect the trade from what appeared to be an improper practice, by issuing a proclamation respecting the increase of weight of silk dyed black upon the gum, which was then considered as a great fraud, and prohibited accordingly; but upon better information the King thought proper, in 1633, to revoke this prohibition. About the same time a new charter was granted to the Weavers' Company, and by a proclamation issued soon after, they were empowered to admit into the freedom of their company, a competent number of such persons, as well strangers as natives, as had exercised the trade of weaving at least one whole year before the date of the new charter, "who shall be conformable to the laws of the realm, and the constitutions of the Church of England." It has been justly asked, What had the constitution of any church to do with the trade of weaving? What other political qualification could be requisite, but that the weaver should be a peaceable subject, and, considering the times, a Protestant of some denomination or other? But many similar instances may be found, in which bigotry and party zeal imposed injudicious restrictions on trade and manufactures.

In 1661 the silk throwsters petitioned parliament, in order to obtain the legislative sanction to some regulations that were thought necessary for the security of their trade, which they asserted employed above forty thousand men, women, and children; and, in consequence of this application, the privileges of the company were extended to twenty miles round London; and it was enacted, that none should set up the trade of a silk-throwster, but such as had served seven years' apprenticeship to it, and should make themselves free of the company.

In 1680 the Weavers' Company petitioned the House of Commons against the importation of foreign silks from France, and the wear of East India wrought silks, which had then become very general; but it does not appear that any thing was done in consequence of this application. The Turkey Company about the same time renewed a complaint they had before made at different times against the East India Company, for importing raw silk; this article having formerly been wholly imported from Turkey, and being a valuable branch of the commerce of that company, which they were now rapidly losing, it induced them soon after to make a formal complaint to the Privy Council; on which occasion, among other assertions, they denominated the new silk which had been imported from Bengal, "a deceitful sort of raw silk." The India Company, unable wholly to deny this charge, contented themselves with saying, that, with respect to the quality of Bengal silk, it was, like all other commodities, good, bad, and indifferent; and rested their defence chiefly on the more general ground of the importance of the manufacture, and the propriety of encouraging it, asserting that raw silk had become so essential, that it might be compared with sheep's wool and cotton wool; and that since their importation thereof, the silk manufacture had increased in the proportion of one to four. This contest between the two companies for the importation of raw silk proves that it was a valuable branch of trade; and it appears that the manufacture was increasing rapidly; but nothing contributed so much to its full establishment in this country, as the cruel persecution of the Protestant Christians in France, on the revocation of the Edict of

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Nantes, in 1685. Of the multitudes who fled at that period, upwards of fifty thousand took refuge in England, the greater part of whom settled in the suburbs of London; those who had been engaged in silk-weaving, chiefly, fixed their residence in Spitalfields, where they added to the branches of this art, already known, those of modes and lustrings, which articles had hitherto been imported from France; they also instructed our weavers in brocades, satins, mantuas, and velvets. Soon after the revolution, in consequence of the war, an act was passed prohibiting all trade and commerce with France, a measure which must have co-operated very materially with the arrival of the new workmen to the success of the silk trade in this country, as the annual importation of French silks had been very great for some years before. In 1692, lustrings and modes being much in fashion, and the fabrication of them but recently introduced here, the makers, for their encouragement, had a patent granted them, and soon brought this branch to the greatest perfection; upon which, about five years after, foreign lustrings and modes were entirely prohibited, and the sole privilege of making these silks confirmed to the company by Act of Parliament for the term of fourteen years; but with the change of fashion this company came to nothing. In 1697, the weavers of London became very tumultuous, on account of the great quantities of silks, stained calicoes, and other Persian and Indian manufactures, imported by the East India Company, and worn by all sorts of people.

To remedy these complaints, a bill was brought into parliament to restrain the wearing of these foreign goods, and the House of Lords heard counsel and witnesses for and against it: the India Company on this occasion engaged the celebrated Dr. Davenant to write in their defence, who, in his essay on the East India Trade, asserted, that since the goods imported by the Company had been in use, the price of silks from France, Spain, and Italy, had fallen at least twenty-five per cent; and endeavoured to show, that the intended prohibition would be destructive to the India trade in general, and hazard its being utterly lost to this country. The contention between the old and new East India Companies greatly increased the importation of India wrought silks and calicoes, and the wear of them became universal, till prohibited by an act of parliament passed in 1700.

In 1713, the Weavers' Company, alarmed at the tendency of a treaty of commerce which had been concluded with France, under which the general introduction of French silks would soon have ruined the English manufacture, petitioned parliament against the bill for rendering effectual the eighth and ninth articles of the treaty, and in their petition they represent the state of the manufacture at that period in the following words: "That by the encouragement of the crown and of divers acts of parliament, the silk manufacture is come to be above twenty times as great as it was in the year 1664; and that all sorts of as good black and coloured silks, gold and silver stuffs and ribbons, are now made here as in France; that black silk for hoods and scarfs, not made here above twenty-five years ago, hath amounted annually to above three hundred thousand pounds for several years past, which before were imported from France, &c. As not only persons concerned in the silk trade, but most other manufacturers and merchants, were against the articles of the treaty which caused this petition, the bill was rejected by the House of Commons, to the great joy of the drapers, mercers, and weavers of London, who expressed their satisfaction at the event by bonfires and illuminations.

A few years after, the art of throwing fine raw silk into organzine was introduced into this country by Messrs. Thomas and John Lamb; but some impediments arising to the success of the undertaking, their machinery was afterwards applied to throwing train and singles. See ORGANZINE.

The decline of the Turkey trade being attributed at this period to the French exporting woollens to Turkey, and taking raw silks in return, which were afterwards brought from Italy into this country, an act was passed prohibiting the importation of raw silk, the produce of Asia, from any ports in the Straits or Levant seas, except such ports and places as are within the dominions of the Grand Seignior. It was also thought proper to pass an act for encouraging the consumption of raw silk, by rendering more effectual a former act respecting the trifling articles of buttons and button holes. In 1721, a much more important act was passed, allowing drawbacks on different descriptions of manufactured silk goods, when exported. In 1750, an act was passed for reducing the duties then payable on the importation of China raw silk, to the same duty as was payable on raw silk imported

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from Italy, which was certainly an advantage to the manufacture. China silk being of a quality peculiarly adapted to several purposes, particularly in the gauze branch, which, at one time consumed a large proportion of it, though it has since become inconsiderable. By the act just mentioned, the East India Company were enabled to increase with advantage their import of silk, which at that time was not very considerable, raw silk being still principally brought from Turkey.

Total quantity of raw silk imported into Great Britain in the year 1750.

From Flanders - - - -	1,407 *lbs.*
Spain and Portugal -	2,564
Straits - - - - - -	14,897
Italy - - - - - -	36,301
Turkey - - - - -	132,894
East Indies - - -	43,876
	231,939

In 1763, an act was passed for rendering more effectual the act of 19 Henry VII. by imposing fines on the importers or venders of the articles therein prohibited, in addition to the forfeiture of the goods. This measure, though it might in some degree check the introduction of foreign articles, was by no means adequate to the object it had in view, as the importation still continued, which, from the jealousy and discontent it excited among the workmen in this manufacture, appeared likely, in the beginning of the year 1765, to be attended with serious consequences. The journeymen weavers and others connected with the trade, who conceived themselves injured by the common use of French silks, assembled in Spitalfields and Moorfields by beat of drum, in order to petition Parliament for redress by a total prohibition of such articles, and from thence proceeded in different bodies to St. James's and Westminster Hall. This disposition, and the report that the weavers in the inland towns were coming to London to join their distressed brethren, excited considerable alarm; they were, however, prevented from committing any great outrage, and finally appeased, by a seasonable subscription for their relief, and an association among the principal mercers to recall all the orders they had given for foreign manufactures. An act was also passed, prohibiting the importation of foreign manufactured silk stockings and gloves into Great Britain and the British dominions, and for rendering more effectual the act passed in 1763 for prohibiting other articles. For the encouragement of the throwing part of this manufacture, an act was likewise passed in 1765, for reducing the duties then payable on the importation of raw silk, for allowing a drawback on the exportation of raw and thrown silk to Ireland, and for prohibiting the exportation of raw silk from Ireland. In the next year an act was passed to prohibit the importation of foreign manufactured silks and velvets, and for preventing unlawful combinations of workmen employed in the silk manufacture; the preamble to the act stated, that great quantities of foreign wrought silks and velvets were daily brought into and sold in Great Britain. By another act a heavy additional duty was imposed on Italian silk crapes and tiffanies, imported into this country.

Towards the end of the year 1767, it was determined, that all future court mournings should be shortened to one half of the time which had been usually observed. This was considered particularly beneficial to the silk manufacture, and the Weavers' Company presented an address to his Majesty on the occasion, in which they assured him that his benevolent resolution would "greatly promote the silk manufactures of this kingdom, give great spirit to the trade, tend to the improvement of it in many branches, and be the means of giving constant employment to the workmen, many of whom, owing to the late mournings, have been out of employ, and in want of bread." They also expressed their obligations to the Queen and the rest of the royal family, for their patronage and encouragement of the silk manufacture. An address was likewise presented on the same occasion, signed by all the principal merchants, manufacturers and others connected with the silk trade.

The journeymen weavers, probably, supposing that, by their combination and riotous proceedings a few years before, they had obtained the exclusion of foreign silks, now adopted the same mode for obtaining an advance in the prices paid for workmanship, which being resisted by their employers, the men proceeded to the most disgraceful acts of violence and atrocity, associating together under the name of cutters, and going about in parties at night, disguised and armed with pistols, cutlasses, and other weapons; breaking into the houses of those workmen who did not join them, but followed their employ as usual, and

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cutting to pieces and destroying all the silk they found in the looms of such workmen. The value of the silks thus destroyed was very considerable; and, in some instances, they ill-treated or murdered those whom they found at work. Several were brought to justice; but it was a considerable time before this lawless disposition entirely subsided. In a dispute between masters and workmen, respecting pay, the opposite interests of the parties must always render it difficult to come to an amicable adjustment, and, after various attempts in this instance, an act was passed in 1773, to authorize the magistrates of the cities of London and Westminster, the county of Middlesex, and the liberty of the Tower, to settle the pay of the workmen in the different branches of this manufacture, in their respective districts.

On the extension of the war in 1779, much inconvenience was experienced from the want of a sufficient supply of Italian thrown silk, caused in a great measure by an act of 2 William and Mary, by which the importation of Italian thrown silk was prohibited, unless imported according to the Navigation Act, and directly by sea, from some of the ports of the country of its growth or production: this regulation was therefore now suspended, and organzine silk, of the growth or production of Italy, was permitted to be imported from any port or place, or in any ships or vessels whatsoever. In consequence of this permission, the silks of Italy were brought to England by a circuitous route over land, and imported from Ostend and other ports of Flanders, till the peace. At a period of the war, when the falling-off of the silk trade was very considerable, Mr. John Callaway, of Canterbury, fortunately introduced a new article, which afforded employment to many hands. It was called Canterbury muslin, by which name it is still known, and many elegant varieties having been produced: it gives employment to many hundred persons in London and elsewhere.

As the prohibition of the importation of foreign manufactured silks did not extend to Italian crapes and tiffanies, which were permitted to be imported under a heavy duty, it was thought proper, in 1791, in consequence of improvements in the manufacture of these articles, to restrict this permission, by prohibiting the importation of silk crapes and tiffanies, of the manufacture of Italy, unless brought directly from thence, and by discontinuing the allowance of drawback on exportation.

The continual frauds committed by the different classes of persons employed in this manufacture, by purloining part of the silk entrusted to them, and resorting to various expedients for increasing the weight of the remainder, which frequently rendered the part stolen but a small part of their employer's loss; and the difficulty of convicting the persons who encouraged these practices by purchasing the stolen silk, caused an act to be passed in 1792, by which, persons buying or receiving, in any manner, silk, from those employed to work it up, knowing them to be so employed, and not having the consent of the employer, are liable to punishment by fine, imprisonment, or whipping, although no proof should be given upon the trial, to whom the silk actually belonged.

In the year 1793, this manufacture was affected more, perhaps, than any other, by the general commercial distress which then prevailed. The merchants, and particularly the East India Company, had large quantities of silk in their warehouses and the manufacturers were overstocked with goods, which brought the trade into a state of almost complete stagnation, by which most of the workmen engaged in it were thrown out of employ, and experienced great distress. A public subscription was opened for their relief, and very liberally supported, from which the unemployed workmen and their families were supplied with bread; and when, from the approach of winter, their necessities increased, their relief was extended to other essential articles. By the report of the committee who superintended the distribution, it appeared that there were given away 795 chaldrons of coals, 583 pair of blankets, and in bread 121,741 quartern loaves. It was considered as a moderate computation, that 5,000 persons were totally unemployed, and that 5,000 more were only about half employed.

In the course of the succeeding three or four years, the manufacture recovered its usual activity, and in the year 1798 was in a more flourishing situation than it had been in for several years previous. In the following year, the revival of velvets, as an article of female dress, proved very favourable to the workmen, as it rendered the employment of a greater number of hands necessary; and in 1800, few persons in this line were out of employ, although the trade was somewhat checked by a considerable advance in the prices of raw and thrown silks.

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TOTAL QUANTITY OF SILK IMPORTED INTO GREAT BRITAIN.

	Bengal Raw.	China Raw.	Italian and Turkey Raw.	Thrown Silk.	Total.
In 1801	351,825*lbs.*	131,33[illegible]*lbs.*	255,951*lbs.*	275,149*lbs.*	1,014,260*lbs.*
1802	111,737	75,588	372,404	396,210	955,939
1803	405,621	74,538	323,630	384,764	1,188,563
1804	624,878	90,362	317,141	449,182	1,481,563
1805	844,659	72,041	267,850	433,272	1,617,822

The annual quantity imported on an average of the above years, is 1,251,629 pounds, from which deducting 79,206 pounds, the average quantity of raw and thrown silk imported during the above period, it leaves 1,172,423 pounds for the quantity consumed in the manufacture.—Hence it appears, that the total annual value of this manufacture must be about 3,500,000*l.* of which but a small proportion is destined for exportation, the total annual value exported being about 700,000*l.*; more than half of which goes to America. During the year 1808, the exportation to America was suspended, and at the same time the interruption of commercial intercourse with the continent of Europe stopped, for a considerable time, the usual supply of silk from Italy; from which circumstances, the manufacture was brought into a very unprecedented situation, silk being sold in London at prices far greater than had ever been given before, while many of the masters were obliged to discharge the principal part of their workmen, from the demand for silk goods having, for a time, almost entirely ceased. These temporary embarrassments all manufacturers are liable to, particularly such as, like this, depend on other countries for their materials.

Silk, in chemistry, in its natural state, contains a kind of yellow resinous matter, which gives its fine golden colour. When raw silk is infused in water, a portion of gummy matter is dissolved, and a light amber-coloured liquor is produced. Alcohol extracts a much deeper yellow, and makes a tincture that loses none of its colour by long exposure to the sun-beams, which bleaches the silk itself. Nitrous acid acts powerfully on silk; but, when concentrated nitric acid is distilled off silk, and the remaining liquor duly evaporated, much oxalic acid is obtained; and the residue, if evaporated, still further yields, with the remaining oxalic acid, a quantity of yellow, granular crystals, extremely bitter, not acid, and staining the saliva and hands of a deep yellow, not easily removed. If the liquor is previously saturated with potash, and evaporated, another yellow silky salt separates, which detonates on coals like common nitre, and appears to be a triple combination of the former bitter substance with nitrate of potash.

SILPHA, in natural history, the *carrion beetle*. Antennæ clavate; the club perfoliate; shells margined; head prominent; thorax somewhat flattened, margined. There are about 140 species, divided into sections. A. Lip dilated, bifid; jaw-one-toothed. B. Lip rounded, entire; jaw one-toothed. C. Lip horny, entire; jaw bifid. D. Lip emarginate, conic; jaw bifid. E. Lip heart-shaped, emarginate, crenate. F. Lip square, emarginate. G. Lip long, entire; antennæ serrate. H. Lip and jaw unknown. The insects of this genus are usually found among decaying animal and vegetable substances; frequenting dung-hills, carrion, &c. and deposit their eggs chiefly in the latter. The larvæ are of a lengthened shape, roughened with minute spines and protuberances. S. vespillo is the most remarkable among European species: this is not uncommon in our own country. The animal is about three-quarters of an inch long, and is distinguished by having the wing-sheaths considerably shorter than the abdomen. It seeks some decaying animal substance, in which it may deposit its eggs, and for the greater security contrives to bury it under ground. Sometimes three or four insects, working in concert, have been known to drag under the surface the body of a mole in the space of an hour, so that no trace of it has appeared above ground: the eggs are white and oval: from these are hatched the larvæ, which, when full grown, are more than an inch long. Each larvæ forms for itself an oval cell in the ground, in which it changes to a yellowish chrysalis, resembling that of a beetle, out of which, in somewhat less than three weeks, proceeds the perfect insect. This species diffuses a strong and unpleasant smell; it flies with considerable strength and rapidity, and is ge-

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nerally seen on the wing during the hottest part of the day.

SILPHIUM, in botany a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu.—Essential character: calyx squarrose; seed down, margined, two-horned; receptacle chaffy. There are eight species.

SILVER, which is divided by mineralogists into three species, the native, antimonial, and the arsenical, has been reckoned among the noble or perfect metals, and has been known from the earliest ages of the world. Its scarcity, beauty, and utility, have always rendered it an object of research among mankind, so that the nature and properties of this metal have been long studied and minutely investigated. In the midst of the rage for the transmutation of metals, which for centuries fired the imaginations of the alchymists, silver occupied a great share of their attention and labour, with the hope of discovering the means of converting the baser and more abundant metals into this, which is more highly valued on account of its scarcity and durability. When the dawn of science commenced, and its light had dissipated the follies and extravagances of these pursuits, the earliest chemists were much employed in examining the properties and combinations of silver; nor has it been overlooked or neglected by the moderns. Silver, which is neither in such abundance nor so universally diffused as many other metals, exists in nature in five different states; in the native state; in that of alloy with other metals, especially with antimony; in that of sulphuret, sulphurated oxide, muriate, and carbonate.

1. Native silver, which is characterized by its ductility and specific gravity. is frequently tarnished on the surface, of a grey or blackish colour, and appears under a great variety of forms. In this state it is not perfectly pure. It is usually alloyed with a little gold or copper.

2. The alloy of silver and antimony, which is the most frequent, is distinguished by its brittleness and lamellated structure from native silver, which it resembles in lustre and colour It crystallizes in prisms, which are six-sided, and pretty regular.

3. The sulphuret of silver, which is known to mineralogists by the name of vitreous silver ore, is of a dark grey colour, and has some metallic lustre. It is usually crystallized in the form of cubes, octahedrons with angular facets, or sometimes in the form of the dodecahedron.

4. The sulphurated oxide of silver and antimony. In this ore of silver the sulphur is combined with the metal in this state of oxide; in the former, in the metallic state. This ore is called red silver ore. It is of a deep red colour, sometimes transparent, and sometimes nearly opaque, frequently having the lustre of steel on the surface. The primitive form of its crystals is the rhomboidal dodecahedron.

5. The muriate of silver, which has been long known to mineralogists by the name of corneous silver, is found in irregular masses, of a greyish colour, frequently opaque, but sometimes semi-transparent. It is soft, and very fusible.

Native silver is generally found in irregular shapes; sometimes in masses of no determined form, sometimes branched, occasionally in capillary filaments, and not uncommonly in leaves. Thus it appears in most mines, and particularly in those of Siberia, where Patrin tells us he never met with it crystallized. It is found in the mines of Peru in a vegetable form, imitating the leaves of fern. This variety of figure in native silver is occasioned by a vast number of little eight-sided crystals, so disposed upon each other as to give the whole the appearance of a vegetable. The curved cylindrical filaments, in which form silver is sometimes found, are of various sizes, from the thickness of a finger, to the diminutive size of a hair. Native silver, as we have observed, is seldom found pure, but is generally mixed with other metals; such as gold, copper, mercury, iron, lead, &c. This last metal almost always contains a portion of silver, though frequently so small as not to be worth the expense of separating it. In the reign of Edward the First nearly 1600 pounds weight of silver were obtained, in the course of three years, from a mine in Devonshire, which had been discovered about the year 900. The lead mines in Cardiganshire have, at different periods, afforded great quantities of silver. Sir Hugh Middleton is said to have cleared from them 2000 pounds in a month. The same mines yielded, about the year 1745, eighty ounces of silver out of every ton of lead. The lead ores from Brunghill and Skekorn produced also a considerable quantity of silver. The lead only, in one of the smelting houses at Holywell, in Flintshire, produced no less than 31,521

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ounces, or 3126¾ pounds of silver, from the year 1754 to 1776. "There are some lead ores in this country." says Dr. Watson, "which, though very poor in lead, contain between three and four hundred ounces of silver in a ton of that metal. It is commonly observed, that the poorest lead-ores yield the most silver, so that a large quantity of silver is probably thrown away in England, from not having the poorest sort of lead-ores properly assayed."

Silver in its mineral state occurs massive, disseminated, in blunt cornered piece, in plates, and in membranes: it is said to occur also in Spanish America in rolled pieces. Its crystallizations are very various, as the cube, octahedron, prism, pyramidal, &c.: the crystals are small and microscopic. It is chiefly found in primitive earths, especially in those which are depositied in beds, though it is not confined to these alone. It is very rarely met with in granite, but not uncommonly in the fissures of micaceous rocks, and in other places of a similar nature, but of more recent formation. In the secondary earths silver often occurs, being found in chalk, slate, &c.; but almost always mineralized by sulphur or arsenic. It is a singular fact, that the situations of gold and silver mines should often be diametrically opposite in point of temperature. Gold is common in the hottest parts of the earth, while we generally find silver mines in the cold regions. Thus, the chief parts of the world where silver is to be met with are, Sweden, Norway, and the higher latitudes near the pole: if we find it in hot climates, it is seldom on level ground; but, on the contrary, raised to a great height, towards the tops of mountains that are perpetually covered with ice and snow. It is thus situated in the Alpine mountains of Europe and America; and such are the mines of Allemont in France, and those of Potosi in the Andes. The principal silver mine in Europe is that of Konigsberg, in Norway, to the north of Christiana. This is the richest, the most important, and one of the most singular mines in that quarter of the globe. The district in which it is situated is mountainous; and the mines are divided into superior and inferior, on account of their relative position. The earth is composed of beds nearly in a vertical position, and running from north to south. Some are composed of quartz mixed with mica, of granite and of chalk: while others are formed of whitish-grey quartz, mixed with fine blackish mica, or else consists of ferruginous rock. These beds are of very considerable thickness, and contain a great quantity of native as well as of mineralized silver. The veins are richer in mineral, and their produce more considerable, where they traverse the beds of ferruginous rock, than in any other part. The most remarkable mine of silver in Spain is that of Guadalcanal, in Andalusia, which was formerly very rich, and well known to the Romans. It is situated in the Sierra Morena, or black mountain, on the confines of Andalusia and Estremadura, fifteen leagues to the north of Seville, and several miles to the north-east of the famous quicksilver mine at Ald Almaden. The mineral obtained here is the ruby silver ore. But it is in the centre of the Andes, in situations which, though immediately exposed to the perpendicular rays of the sun, are constantly covered with snow, that nature has most abundantly distributed this metal. In twenty degrees of southern latitude, within the torrid zone, we find the famous mountain of Potosi, situated near the source of the Rio de la Plata. This mountain is one of the most considerable in Peru; its height is immense; and it appears, from the description of travellers, that from top to bottom it is full of veins of silver. When these mines were first discovered, in the year 1545, the veins were so rich as to be almost entirely composed of silver without any mixture. At present, however, the produce is very different, scarcely more than five drachms being obtained from a hundred weight of ore; still, from the great abundance of mineral, the produce is very considerable. According to the observations of several Spanish naturalists, the mountain of Potosi alone, from the time it was first discovered, in 1545, till the year 1638, that is, in the space of ninety-three years, yielded four hundred millions of pesos, or ounces of silver.

The analysis of silver varies according to its nature and combinations. Native silver, after being broken down and washed, is rubbed with liquid mercury, which by strong trituration dissolves and combines with the silver. This amalgam is subjected to pressure, to separate, the excess of mercury. It is then distilled, and afterwards heated in a crucible to volatilize the mercury, and the silver remains pure. When silver is combined with antimony and sulphur, the ore is to be strongly roasted, to separate the antimony or sulphur. It is then melted

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with a proper quantity of alkaline flux. The sulphurated oxide of silver and antimony may be treated in the same way. See ASSAYING.

Silver is of a fine white colour and great brilliancy. The specific gravity is 10.4, and according to some, when it is hammered, 10.5, and sometimes nearly 11. The hardness of silver is intermediate between iron and gold. The elasticity of silver is considerable, and it is one of the most sonorous of the metals. It possesses very great ductility and malleability. It may be beaten out into leaves of $\frac{1}{100000}$ of an inch thick, and a grain of silver may be so extended, as to be formed into a hemispherical vessel of sufficient capacity to hold an ounce of water, or to be drawn out into a wire four hundred feet in length. The tenacity of silver is very great. A wire .078 of an inch in diameter will support a weight of one-hundred and eighty-seven pounds avoirdupois. Silver is a good conductor of caloric. Its expansive power is less than that of lead and tin, and greater than that of iron. When it is exposed to a white heat it melts. The temperature necessary to bring it to fusion has been calculated at the 1000° of Fahrenheit; but, according to Kirwan, it requires a higher temperature than 28° Wedgewood to melt it, although at that temperature it continues in a state of fusion. When it is cooled slowly after fusion, it exhibits some marks of crystallization. It assumes the form of four-sided pyramids or of octahedrons. If the heat be increased after the silver is melted, it boils, and may be reduced to vapour. The surface of melted silver is so extremely brilliant, that it seems to throw out sparks, which is called coruscation by the workmen. Silver is a good conductor of electricity. It has no perceptible taste or smell.

Silver is not altered by exposure to the air, although it is soon tarnished, which is owing, as Proust ascertained, to a thin covering of sulphuret of silver, which is formed by sulphureous vapours to which it is exposed; but when it is subjected to a strong heat for a long time, in an open vessel, it combines with the oxygen of the atmosphere, and is converted into an oxide. In the experiments of Macquer, the oxydation of silver was effected by exposing it for twenty times successively, in a crucible, to the strong heat of a porcelain furnace. At last perceptible traces of oxydation were observed, and a vitreous matter of an olive colour was obtained. In other experiments silver being acted on by the heat of a burning-glass was covered with a white powder, which was afterwards converted into a crust of a green colour. Van Marum passed electric shocks through silver wire, which was instantly reduced to a kind of powder, with a greenish white flame, and the oxide which was formed was dissipated in vapour. The oxide of silver, which is formed by these processes, is of a greenish or yellow colour. It is composed of about ten parts of oxygen, and ninety of silver. The oxide of silver is very easily reduced, for the affinity of oxygen for this metal is very feeble. It is decomposed by the application of heat, and even when it is exposed to the light. By heating it in close vessels, pure oxygen gas is obtained, and the metal is converted to the metallic state, by melting it in a crucible.

Silver combines with phosphorus, forming a phosphuret. One part of silver in filings, with two of phosphoric glass, and half a part of charcoal, exposed to heat in a crucible, yielded a phosphuret of silver, which had acquired one-fourth of its primitive weight of silver. This phosphuret is of a white colour, brittle, of a granulated texture, and may be cut with a knife. By throwing pieces of phosphorus on silver red hot in a crucible, the metal is instantly melted, and the phosphuret which is formed remains at the bottom. At the moment when the surface becomes solid, a quantity of phosphorus is thrown out with a kind of explosion, and the surface of the metal then exhibits a mamellated appearance. Pelletier, who first made this experiment, concludes from it, that silver is susceptible of retaining a greater proportion of phosphorus, in combination with it, when it is in fusion, than in the solid state, and that the separation of the phosphorus is owing to the sudden contraction of the silver. A hundred parts of silver in fusion retain twenty-five of phosphorus, but only fifteen when it becomes solid.

Phosphorus has the property of reducing the oxides of silver, and of precipitating them from this solution in acids, in the metallic form. Sulphur combines readily with silver, both in the dry and humid way. By stratifying in a crucible, plates of silver alternately with sulphur, and melting them rapidly, a deep violet-coloured mass is obtained, which is more fusible than silver, brittle, crystallized, and has a metallic lustre. It may be cut with a knife, and has a

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good deal of resemblance to vitreous ore of silver. When this sulphuret of silver is exposed to heat for a considerable time, the sulphur is gradually dissipated, and the silver remains pure and ductile. Silver combines very readily with sulphur, when it is long exposed to those matters which gradually deposit this substance. This effect is immediately produced when silver is brought into contact with sulphurated hydrogen gas, or when it is immersed in water, impregnated with this gas, as in natural sulphureous waters. Dr. Thomson thinks it is owing to the same cause, that a silver spoon is tarnished by a boiled egg, and particularly if the egg has begun to spoil. Sulphuretted hydrogen gas, which is exhaled by the egg, is decomposed; the sulphur combines with the silver, and forms a thin layer of sulphuret of silver, which is of a dark or violet colour; other writers have ascribed this to the action of galvanism. The same thing happens when silver is exposed in places that are much frequented, as in churches and theatres. Silver forms alloys with most of the metals, and salts with the acids. Hence its use in coinage, and also in medicine.

Antimonial silver, in colour, is between silver white and tin white; sometimes inclining more to the one, sometimes more to the other. It occurs massive, disseminated and crystallized. Specific gravity between 9 and 10. Heated on charcoal before the blow-pipe, the antimony is volatilized with the odour peculiar to it, and there remains a mass of silver, surrounded with a brown slag. It consists, according to Vauquelin, of

Silver - - - - - - -	78
Antimony - - - -	22
	100

It occurs in veins which are composed of calc-spar, heavy-spar, and is accompanied with lead glance and native silver. It is distinguished from native silver by its brittleness, and a foliated fracture.

Arsenical silver is of a tin white colour, which passes into silver white, and verges on light lead grey. It is always more or less tarnished with a blackish colour. It occurs massive, disseminated and globular. It consists of

Arsenic - - - -	35
Iron - - - - -	44.25
Silver - - - - -	12.75
Antimony - - -	7
	100.

Before the blow-pipe the arsenic and antimony are volatilized, and they emit a garlic-like smell. The silver remains more or less pure in shape of a globule. This is a very rare mineral, and does not tarnish so quickly as native arsenic; it passes on the one side into native arsenic; on the other into native silver.

SILVERING, in the arts, consists in covering the surfaces of substances with a thin coating of silver; either for the purpose of beauty, silver being so much more handsome than the inferior metals; or, on account of its superior wholesomeness, compared with copper, brass, or lead, for culinary purposes, it resisting the corroding power of vinegar and other weak acids. The metals that are usually covered with silver are, copper and brass, and sometimes iron, and there are three distinct modes of performing the operation. 1. Silvering, by amalgamation, is thus performed: to a solution of nitrated silver add some plates of copper, which will throw down the silver in its metallic state, and very finely divided; scrape it from the surface of the copper, wash it well and dry it. Of this powder take half an ounce, of common salt and sal ammoniac two ounces, and of corrosive sublimate one drachm, rub them well together, and make them into a paste with a little water. Then take the vessel to be silvered, and clean it by means of a little very dilute aquafortis, or by scouring it with a mixture of common salt and tartar. When it is perfectly clean, rub it with the above-mentioned paste till it is entirely covered with a white metallic coating; this coating is an amalgam produced by the decomposition of the corrosive sublimate, by means of the copper, to the surface of which it applies very closely and expeditiously. The copper, being thus silvered over, is to be washed, dried, and afterwards heated nearly red, in order to drive off the mercury; the silver remains behind, adhering firmly to the copper, and capable of being highly polished. 2. Silvering by luna cornea. Prepare the luna cornea in the usual manner, by pouring a solution of common salt into nitrate of silver, as long as any precipitation takes place, and boiling the mixture; the white curdy matter, thus obtained, is to be mixed with three parts of good pearl-ash, one part of washed whiting, and somewhat more than one part of common salt. The surface of the brass, being cleared from scratches, is to be rubbed with a piece of old hat and rotten stone, to remove any grease, and then is

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to be moistened with salt and water; a little of the composition being now rubbed on with the finger, the surface of the metal will presently be covered with silver. Then wash it well, rub it dry with soft rag, and, as the coat of silver is extremely thin, cover it with transparent varnish, to preserve it from tarnish. This kind of silvering is very imperfect, and is only used for the faces of clocks, the scales of barometers, and similar objects. 3. Silvering by silver in substance. There are three ways of performing this. The first is, by mixing together twenty grains of silver, precipitated by copper, two drachms of tartar, two drachms of common salt, and half a drachm of alum; this composition being rubbed on a perfectly clean surface of copper or brass will cover it with a thin coating of silver, which may afterwards be polished with a piece of soft leather. A still better way is that which is called French plating, which consists in burnishing down upon the surface of the copper successive layers of leaf-silver to any required thickness. In this the silver has much more solidity than in any of the former, but the process is tedious, and the junctures of the leaves of silver cannot always be entirely concealed. The English method of plating (in those works to which it is applicable) appears to be the best of all. It is thus performed: one of the surfaces of an ingot of copper is rendered quite smooth and clean, and is sprinkled over with glass of borax; upon this is laid a plate of fine silver, about one-twelfth of the weight of the copper, and the two are carefully bound together by wire; the mass is now exposed to a full red heat, which melts the borax, and causes the silver to adhere to the copper; the ingot is now passed through a rolling press, and formed into a plate; both the silver and copper extending uniformly during the whole process, at the conclusion of which, the two metals are inseparably fixed to each other. See Aikin's "Dictionary."

SILURUS, the *silure*, in natural history, a genus of fishes of the order Abdominales. Generic character: head large, naked, and depressed; mouth extremely wide, and furnished with long feelers or tentacula; eyes small, body lengthened, naked; first ray of the pectoral or dorsal fin serrated with reversed spines. There are twenty-nine species, of which the following most deserve notice.

S. glanis is generally about three feet long, though it has been seen of twelve, and of the weight of three hundred pounds, and consequently is one of the very largest of European river fishes. It is most plentiful in the north, is seldom seen in motion, and commonly lies ingulfed in mud at the bottoms, with its mouth open, and its long tentacula moving about in every direction. These last being similar in appearance to worms, are mistaken for such by many fishes, which are, by this deception, drawn within the jaws of destruction. Its flesh is used for its cheapness, rather than its excellence, and its skin, by some simple process, is converted into a hard, transparent substance, which accomplishes the purposes of horn and glass.

SIMIA, the *ape*, in natural history, a genus of Mammalia, of the order Primates. Generic character: front teeth in each jaw four, near together; canine teeth solitary, longer than the others, distant from the grinders; grinders obtuse. Animals of this genus are commonly divided into such as have no tails; such as have only very short ones; such as have very long ones; and, lastly, such as have prehensile tails, with which they can lay hold of any object at pleasure. These four classes are called respectively apes, baboons, monkeys, and japajous. In the whole genus there are enumerated by Gmelin sixty-three species, of which we shall notice some of the most important.

S. satyrus, or the orang-outang. This animal is said to grow in its native woods of Africa and India to the height of six feet, and to subsist, like most other species, on fruits. It flies from the haunts of mankind, leads a solitary life, and displays great strength, agility, and swiftness, which render it extremely difficult to be taken. It has been known to attack and destroy negroes wandering at a distance from their habitations, and to carry off women to its wretched habitation, watching them with such extraordinary vigilance, as scarcely to admit the possibility of their escape. Its general resemblance to the human figure and countenance, is particularly and mortifyingly strong, yet minute observation and dissection have pointed out almost innumerable differences, the detail of which is here impossible. It is capable of being tamed and domesticated, and many years since, one was exhibited in London, which had been disciplined to sit, and work, and eat like a human being, using a knife and fork for the latter purpose. Its disposition was pensive; its manners were gentle; and it appear-

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ed to possess, for its keepers, and those to whom it had been long familiarized, a high degree of genuine gratitude and attachment. For the orang-outang, see Mammalia, Plate XIX. fig. 1.

S. inuus, the Barbary ape, is about four feet in height, and is the species most commonly exhibited in public shows, and is trained to the performance of a great variety of tricks, calculated to attract popular admiration. The discipline it passes through is often severe, and this species is considered, in its natural state, as being more ferocious, and less sagacious, than several others of the class. See Mammalia, Plate XIX fig. 2.

S. sphynx, or the great baboon, is between three and four feet high, of a grey brown colour, and is particularly muscular in the upper part of its body; its hands and feet have sharp nails, like claws; but on its thumbs there are nails formed like those on the human fingers. It is an animal incapable of domestication, and has, in no instance, been observed to be divested of great malignity and fierceness of disposition. The female produces only one young one at a birth, which she suckles at her breast, and carries about with her in her arms. Baboons inhabit the hottest climates of Africa, and are often seen in very considerable numbers. The plantations of fruits and roots are frequently much injured by their depredations. They are scarcely, in any species, susceptible of attachment. In confinement, they display incessant restlessness and irritation, and in their form and manners they present a complication of ferocity and hideousness. See Mammalia, Plate XIX. fig. 3.

S. hamadryas, or the dog-faced baboon, is very large, and often greater than the common baboon. It is distinguished by a vast quantity of hair, spreading from each side of the head down the shoulders, and covering the animal to the waist, like a mantle. Its colour is a mixture of grey and brown. It is a ferocious and dangerous animal, is found in the most torrid regions of Africa, and though more rare than the common species, is yet seen occasionally in large companies. Its general aspect, when in an undisturbed state, is that of profound meditation; but when molested, its looks indicate the most perturbed and malignant feelings. In confinement, it is turbulent, untractable, and filthy. The tail of this baboon is nearly as long as its body.

S. leonina, or the leonine monkey, is supposed to be an inhabitant of Abyssinia, and is two feet in length, from the nose to the tail; along the face is a great quantity of long hair, extending nearly from the eyes back over the forehead and crown of the head, and from the chin over the neck, and this bushment of hair gives it, in addition to the general form and countenance of the animal, no slight resemblance to the lion, from which it derives its designation. See Mammalia, Plate XIX. fig. 4.

S. mona, or the varied monkey, is one of the largest species, and is nearly two feet in length. It is found in various parts of Africa, and differs much in individuals in respect to colours, which are sometimes bright, and at others dull. In general it is of a dark olive-grey. See Mammalia, Plate XIX. fig. 5.

S. nasalis, or the proboscis monkey, is one of the most curious in its aspect, and most ludicrous of the class. It is about two feet in length. The face is of an incurvated form, and of a brown colour, and the nose, which is its great singularity, is of such a length and shape, as to give the animal an appearance highly grotesque. By a groove or furrow running down it, from the beginning to the tip, it is nearly divided into two lobes, and on a side view its extreme projection is nearly as striking and singular, as the former circumstance renders a full one. It is found in the East Indies, where, however, it is somewhat rare. It is said to be more numerous in Cochin China. It feeds on fruits, and is highly untractable and savage.

S. beelzebul, or the preacher monkey, is as large as a fox, and is extremely common in the woods of Brazil. Travellers have stated that it is usual for one of these to ascend a tree, and, by certain sounds, to collect vast multitudes beneath him, when he commences a howl, so loud as to be heard to a vast distance. After this has continued for some time, he, by a particular signal, induces those around him to join in the noise, which then becomes most hideous and intolerable. This united clamour at length ceases, and the original howler again proceeds undisturbed in his address. The throat bone of this monkey appears, from dissection, to be particularly constructed for the utterance of strong sounds.

The S. seniculus, or royal monkey, is about the size of a squirrel, and inhabits the damp woody districts of Cayenne, being never found on the mountains. In its sounds and manners, it resembles the last species. In the morning and evening,

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and sometimes on several occasions in the interval, these animals produce such rattling, terrific, and varied noises, as excite the idea of every native of the forest being in open cry. And even the sounds of a single one are so powerful as to impress the idea of peril very strongly on the hearer. These creatures are extremely tenacious of life. They will often sustain parts of several discharges from guns, before they drop from the tree, which they cling to with the last efforts of existence, sometimes, indeed, maintaining their hold, it is said, by the hands and tail even after death. The two last species belong to the class of monkeys with prehensile tails, or japajous. The greater number of the animals of this comprehensive genus are said to be remarkably fond of snuff, mustard, and tobacco, which they will eat in considerable quantities. A great number of species are furnished with cheek-bags, or pouches, where they may deposit, for the convenience of carriage, a supply of food, which will last for several days after they have finished their immediate repast. Monkeys are, in some parts of Africa, used for food, and several species are said to be excellent and delicate for this purpose.

SIMILAR, in arithmetic and geometry, the same with like. Those things are said to be similar, or like, which cannot be distinguished but by their compresence, that is, either by immediately applying the one to the other, or some other third to them both, so that there is nothing found in one of the similar things but is equally found in the other, notwithstanding their similitude may differ in quantity; and since, in similar things, there is nothing wherein they differ besides the quantity: quantity itself is the internal difference of similar things. In mathematics, similar parts have the same ratio to their wholes, and if the wholes have the same ratio to the parts, the parts are similar. See PART.

Similar angles are also equal angles. In solid angles, when the planes under which they are contained are equal, both in number and magnitude, and are disposed in the same order, they are similar, and consequently equal. Similar arches of a circle are such as are like parts of their whole circumferences, and consequently equal. Similar plane numbers are those numbers which may be ranged into the form of similar rectangles, that is, into rectangles whose sides are proportional; such are 12 and 48; for the sides of 12 are 6 and 2, and the sides of 48 are 12 and 4: but 6 : 2 : : 12 : 4, and therefore those numbers are similar. Similar polygons are such as have their angles severally equal, and the sides about those angles proportional. Similar rectangles as those which have their sides about the equal angles proportional: hence, 1. All squares are similar rectangles. 2. All similar rectangles are to each other as the squares of their homologous sides. Similar right-lined figures are such as have equal angles, and the sides about those equal angles proportional. Similar segments of a circle are such as contain equal angles. Similar curves: two segments of two curves are called similar, if any right-lined figure being inscribed within one of them, we can inscribe always a similar right-lined figure in the other. Similar conic sections: two conic sections are said to be similar, when, any segment being taken in the one, we can assign always a similar segment in the other. Similar diameters of two conic sections: the diameters in two conic sections are said to be similar, when they make the same angles with their ordinates. Similar solids are such as are contained under equal numbers of similar planes, alike situated. Similar triangles are such as have their three angles respectively equal to one another: hence, 1. All similar triangles have the sides about their angles proportional. 2. All similar triangles are to one another as the squares of their homologous sides.

SIMILAR *bodies*, in natural philosophy, are such as have their particles of the same kind and nature with one another.

SIMILAR *figures*, in geometry, such as have their angles respectively equal, and the sides, about the equal angles, proportional.

SIMILAR *parts*, in anatomy, are those parts of the body, which, at first sight, appear to consist of like parts, or parts of the same nature, texture, and conformation; of these we usually reckon ten, *viz.* the bones, cartilages, ligaments, membranes, fibres, nerves, arteries, veins, flesh and skin.

SIMILE, or SIMILITUDE, in rhetoric, a comparison of two things, which, though different in other respects, yet agree in some one. The difference between a simile and comparison is said to consist in this, that the simile properly belongs to whatever we call the quality of the thing, and the comparison to the quantity.

SIMILITUDE, in arithmetic, geometry,

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&c. denotes the relation of two things similar to each other.

SIMONY, is the corrupt presentation of any one to an ecclesiastical benefice, for money, gift, reward, or benefit. It was not an offence punishable criminally at the common law, it being thought sufficient to leave the clerk to ecclesiastical censures. But as these did not affect the simoniacal patron, none were efficacious enough to repel the notorious practice of the thing. Several acts of parliament have, therefore, been made to restrain it, by means of civil forfeitures, which the modern prevailing usage with regard to spiritual preferments call aloud to put in execution.

By one of the canons of 1603, every person, before his admission to any ecclesiastical promotion, shall, before the ordinary, take an oath, that he hath made no simoniacal contract, promise, or payment, directly or indirectly, by himself or any other, for the obtaining of the said promotion; and that he will not afterwards perform or satisfy any such kind of payment, contract, or promise, by any other, without his knowledge or consent.

To purchase a presentation, the living being actually vacant, is open and notorious simony; this being expressly in the face of the statute. But the sale of an advowson during a vacancy is not within the statute of simony, as the sale of the next presentation is; but it is void by the common law.

A bond of resignation is a bond given by the person intended to be presented to a benefice, with condition to resign the same; and is special or general. The condition of a special one is, to resign the benefice in favour of some certain person, as a son, kinsman, or friend of the patron, when he shall be capable of taking the same. By a general bond, the incumbent is bound to resign on the request of the patron. A bond, with condition to resign within three months after being requested, to the intent that the patron might present his son when he should be capable, was held good; and the judgment was affirmed in the exchequer chamber: for that a man may, without any colour of simony, bind himself for good reasons; as, if he take a second benefice, or if he be non-resident, or that the patron present his son, to resign; but if the condition had been to let the patron have a lease of the glebe or tithes, or to pay a sum of money, it had been simoniacal.

SIMOOM. A wind or haze was observed by Mr. Bruce, in the course of his travels to discover the sources of the Nile, which is supposed to be in some respects analogous to the sirocco. It is called by him the simoom, and from its effects upon the lungs, we can entertain but little doubt, that it consists chiefly of carbonic acid gas in a very dense state, and perhaps mixed with some other noxious exhalations.

Mr. Bruce, who, in his journey through the desert, felt the effects of the simoom, gives of it the following graphical description: "At eleven o'clock, while we contemplated with great pleasure the rugged top of Chiggre, to which we were fast approaching, and where we were to solace ourselves with plenty of good water, Idris, our guide, cried out, with a loud voice, fall upon your faces, for here is the simoom. I saw from the south-east a haze coming, in colour like the purple part of the rainbow, but not so compressed or thick. It did not occupy twenty yards in breadth, and was about twelve feet high from the ground. It was a kind of blush upon the air, and it moved very rapidly; for I scarce could turn to fall upon the ground with my head to the northward, when I felt the heat of its current plainly upon my face. We all lay flat on the ground as if dead, till Idris told us it was blown over. The meteor or purple haze which I saw was indeed passed; but the light air that still blew was of heat to threaten suffocation. For my part, I found distinctly in my breast that I had imbibed a part of it, nor was I free from an asthmatic sensation till I had been some months in Italy, at the baths of Poretta, near two years afterwards." Though the severity of this blast seems to have passed over them almost instaneously, it continued to blow so as to exhaust them till twenty minutes before five in the afternoon, lasting through all its stages very nearly six hours, and leaving them in a state of the utmost despondency.

SIMPLE, something not mixed or compounded, in which sense it stands opposed to compound.

Simple, in pharmacy, a general name given to all herbs or plants, as having each its particular virtue, whereby it becomes a simple remedy.

Simple *Contract*, in law, debts by simple contract are such, where the contract upon which the obligation arises is neither ascertained by matter of record, nor yet by special deed or instrument,

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but by mere oral evidence, or by notes unsealed; whereas debts by specialty are such, whereby the contract is ascertained by deed or instrument, under seal. Simple contract debts are to be paid by executors after debts by specialty.

SIMPSON, (Thomas,) in biography, professor of mathematics at the Royal Academy at Woolwich, fellow of the Royal Society, and member of the Royal Academy, at Stockholm, was born at Market Bosworth, in Leicestershire, in 1710. His father, a stuff-weaver, taught him only to read English, and brought him up to his own business; but meeting with a scientific pedlar, who also practised fortune-telling, young Simpson, by his assistance and advice, left off weaving, and professed astrology. As he improved in knowledge, however, he grew disgusted with his pretended art, and renouncing it, was driven to such difficulties for the subsistence of his family, that he came up to London, where he worked as a weaver, and taught mathematics at his spare hours. As his scholars increased, his abilities became better known, and he published his Treatise on Fluxions, by subscription, in 1737; in 1740, he published his Treatise on the Nature and Laws of Chance; and Essay in Speculative and Mixed Mathematics. After these appeared his Doctrine of Annuities and Reversions; Mathematical Dissertations; Treatise on Algebra; Elements of Geometry; Trigonometry, Plane and Spherical; Select Exercise; and his Doctrine and Application of Fluxions, which he professes to be rather a new work, than a second edition of his former publication on fluxions. In 1743, he obtained the mathematical professorship at Woolwich Academy; and soon after was chosen a member of the Royal Society, when the president and council, in consideration of his moderate circumstances, were pleased to excuse his admission-fees, and his giving bonds for the settled future payments. At the Academy he exerted all his abilities in instructing the pupils who were the immediate objects of his duty, as well as others whom the superior officers of the ordnance permitted to be boarded and lodged in his house. In his manner of teaching he had a peculiar and happy address, a certain dignity and perspicuity, tempered with such a degree of mildness, as engaged the attention, esteem, and friendship of his scholars. He therefore acquired great applause from his superiors in the discharge of his duty.

Mr. Simpson's Miscellaneous Tracts, printed in 4to, 1757, were his last legacy to the public: a most valuable bequest, whether we consider the dignity and importance of the subjects, or his sublime and accurate manner of treating them.

The first of these papers is concerned in determining the precession of the Equinox, and the different motions of the Earth's Axis, arising from the Attraction of the Sun and Moon. It was drawn up about the year 1752, in consequence of another on the same subject, by M. de Sylvabelle, a French gentleman. Though this gentleman had gone through one part of the subject with success and perspicuity, and his conclusions were perfectly conformable to Dr. Bradley's observations, it nevertheless appeared to Mr. Simpson that he had greatly failed in a very material part, and that indeed the only very difficult one; that is, in the determination of the momentary alteration of the position of the Earth's axis, caused by the forces of the Sun and Moon; of which forces, the quantities, but not the effects, are truly investigated. The second paper contains the Investigation of a very exact Method or Rule for finding the Place of a Planet in its Orbit, from a correction of Bishop Ward's circular Hypothesis, by means of certain Equations applied to the Motion about the upper Focus of the Ellipse. By this method the result, even in the orbit of Mercury, may be found within a second of the truth, and that without repeating the operation. The third shows the Manner of transferring the Motion of a Comet from a parabolic Orbit to an elliptic one; being of great use, when the observed places of a (new) comet are found to differ sensibly from those computed on the Hypothesis of a parabolic orbit. The fourth is an attempt to show, from Mathematical Principles, the Advantage arising from taking the Mean of a Number of Observations, in practical Astronomy; wherein the odds, that the result in this way is more exact than from one single observation, is evinced, and the utility of the method in practice clearly made appear. The fifth contains the Determination of certain Fluents, and the Resolution of some very useful Equations in the higher Orders of Fluxions, by means of the measures of angles and ratios, and the right and versed sines of circular arcs. The sixth treats of the Resolution of algebraical Equations, by the Method of Surd divisors; in which the grounds of that method, as laid down

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by Sir Isaac Newton, are investigated and explained. The seventh exhibits the Investigation of a general Rule for the Resolution of Isoperimetrical Problems of all Orders, with some examples of the use and application of the said rule. The eighth, or last part, comprehends the Resolution of some general and very important Problems in Mechanics and Physical Astronomy; in which, among other things, the principal parts of the third and ninth sections of the first book of Newton's Principia are demonstrated in a new and concise manner. But what may perhaps best recommend this excellent tract is, the application of the general equations, thus derived, to the determination of the lunar orbit.

According to what Mr. Simpson had intimated at the conclusion of his Doctrine of Fluxions, the greatest part of this arduous undertaking was drawn up in the year 1750. About that time M. Clairaut, a very eminent mathematician of the French Academy, had started an objection against Newton's general law of gravitation. This was a motive to induce Mr. Simpson (among some others) to endeavour to discover whether the motion of the Moon's apogee, on which that objection had its whole weight and foundation, could not be truly accounted for, without supposing a change in the received law of gravitation, from the inverse ratio of the squares of the distances. The success answered his hopes, and induced him to look further into other parts of the theory of the Moon's motion than he at first intended; but before he had completed his design, M. Clairaut arrived in England, and made Mr. Simpson a visit; from whom he learned, that he had a little before printed a piece on that subject, a copy of which Mr. Simpson afterwards received as a present, and found in it the same things demonstrated, to which he himself had directed his enquiry, besides several others.

The facility of the method Mr. Simpson fell upon, and the extensiveness of it, will in some measure appear from this, that it not only determines the motion of the apogee in the same manner, and with the same ease as the other equations, but utterly excludes all those dangerous kinds of terms that had embarrassed the greatest mathematicians, and would after a great number of revolutions, entirely change the figure of the Moon's orbit. From whence this important consequence is derived, that the Moon's mean motion and the greatest quantities of the several equations, will remain unchanged, unless disturbed by the intervention of some foreign or accidental cause. These tracts are inscribed to the Earl of Macclesfield, President of the Royal Society.

Mr. Simpson's extreme application in this difficult pursuit greatly injured his health. Exercise and a proper regimen were prescribed to him, but to little purpose; for his spirits sunk gradually, till he became incapable of performing his duty, or even of reading the letters of his friends. The effects of this decay of nature were greatly increased by vexation of mind, owing to the haughty and insulting behaviour of his superior, the first professor of mathematics. This person, greatly his inferior in mathematical accomplishments, did what he could to make his situation uneasy, and even to depreciate him in the public opinion; but it was a vain endeavour, and only served to injure himself. At length his physicians advised his native air for his recovery, and he set out in February, 1761; but was so fatigued by his journey, that, upon his arrival at Bosworth, he betook himself to his chamber, and grew continually worse till the day of his death, which happened on the 14th of May, in the 51st year of his age.

SIMSON (Dr. Robert), in biography, professor of mathematics in the University of Glasgow, was born in the year 1687, of a respectable family, which had held a small estate in the county of Lanark for some generations. He was, we think, the second son of the family. A younger brother was professor of medicine in the University of St. Andrews, and is known by some works of reputation, particularly "A Dissertation on the Nervous System," occasioned by the dissection of a brain completely ossified.

Dr. Simson was educated in the University of Glasgow, under the eye of some of his relations who were professors. Eager after knowledge, he made great progress in all his studies: and as his mind did not, at the very first openings of science, strike into that path which afterwards so strongly attracted him, and in which he proceeded so far almost without a companion, he acquired in every walk of science a stock of information which, though it had never been much augmented afterwards, would have done credit to a professional man in any of his studies. He became, at a very early period, an adept in the philosophy and theology of the schools, was able to supply the place of

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a sick relation in the class of oriental languages, was noted for historical knowledge, and one of the most knowing botanists of his time. As a relief to other studies, he turned his attention to mathematics. Perspicuity and elegance he thought were more attainable, and more discernible in pure geometry, than in any other branch of the science. To this therefore he chiefly devoted himself; for the same reason he preferred the ancient method of studying pure geometry. He considered algebraic analysis as little better than a kind of mechanical knack, in which we proceed without ideas, and obtain a result without meaning, and without being conscious of any process of reasoning, and therefore without any conviction of its truth. Such was the ground of the strong bias of Dr. Simson's mind to the analysis of the ancient geometers. It increased as he advanced, and his veneration for the ancient geometry was carried to a degree of idolatry. His chief labours were exerted in efforts to restore the works of the ancient geometers. The inventions of fluxions and logarithms attracted the notice of Dr. Simson, but he has contented himself with demonstrating their truth on the genuine principles of ancient geometry.

About the age of twenty-five, Dr. Simson was chosen Regius Professor of Mathematics in the university of Glasgow. He went to London immediately after his appointment, and there formed an acquaintance with the most eminent men of that bright era of British science. Among these he always mentioned Captain Halley (the celebrated Dr. Edmund Halley) with particular respect; saying, that he had the most acute penetration, and the most just taste in that science, of any man he had ever known. And, indeed, Dr. Halley has strongly exemplified both of these in his divination of the work of "Appollonius de Sectione Spatii," and the eighth book of his "Conics," and in some of the most beautiful theorems of Sir Isaac Newton's "Principia." Dr. Simson also admired the wide and masterly steps which Newton was accustomed to take in his investigations, and his manner of substituting geometrical figures for the quantities which are observed in the phenomena of nature. It was from Dr. Simson that his biographer, to whom we are indebted for this article, learnt, "That the thirty-ninth proposition of the first book of the Principia was the most important proposition that had ever been exhibited to the physico-mathematical philosopher; and he used always to illustrate to his more advanced scholars the superiority of the geometrical over the algebraic analysis, by comparing the solution given by Newton of the inverse problem of centripetal forces, in the 42d proposition of that book, with the one given by John Bernoulli in the Memoirs of the Academy of Sciences at Paris for 1713. He had heard him say, that to his own knowledge Newton frequently investigated his propositions in the symbolical way, and that it was owing chiefly to Dr. Halley that they did not finally appear in that dress. But if Dr. Simson was well informed, we think it a great argument in favour of the symbolic analysis, when this most successful practical artist (for so we must call Newton when engaged in a task of discovery) found it conducive either to dispatch, or perhaps to his very progress Returning to his academical chair, Dr. Simson discharged the duties of a professor for more than fifty years, with great honour to the university and to himself. It is almost needless to say, that in his prelections he followed strictly the Euclidian method in elementary geometry. He made use of Theodosius as an introduction to spherical trigonometry. In the higher geometry, he lectured from his own Conics; and he gave a small specimen of the linear problems of the ancients, by explaining the properties, sometimes of the conchoid, sometimes of the cissoid, with their application to the solution of such problems. In the more advanced class, he was accustomed to give Napier's mode of conceiving logarithms, *i. e.* quantities as generated by motion; and Mr. Cotes's view of them, as the sums of ratiunculæ; and to demonstrate Newton's lemmas concerning the limits of ratios; and then to give the elements of the fluctionary calculus; and to finish his course with a select set of propositions in optics, gnomonics, and central forces. His method of teaching was simple and perspicuous, his elocution clear, and his manner easy and impressive. He had the respect, and still more, the affection, of his scholars.

It was chiefly owing to the celebrated Halley, that Dr. Simson so early directed his efforts to the restoration of the ancient geometers. He had recommended this to him, as the most certain way for him, at that time very young, both to acquire reputation, and to improve his own knowledge and taste, and he presented him with a copy of Pappus's Mathematical Collections, enriched with his own notes. Hence he undertook the restoration of Euclid's porisms, a work of such difficul-

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ty, that his biographer says nothing but success could justify in so young an adventurer. From this he proceeded to other works of importance, which he executed with so much skill, as to obtain the reputation of being one of the most elegant geometers of the age. His edition of Euclid's "Elements" has long been reckoned the very best that exists. Another work, on which Dr. Simson bestowed much labour, was the "Sectio determinata," which was published after his death, by the late Earl Stanhope, with the great work, "The Porisms of Euclid." This nobleman had kept up a correspondence with Dr. Simson till his death, in 1768, when he engaged Mr. Clow, to whose care the Doctor had left his papers, to make a selection of such as would serve to support and increase his reputation, as the restorer of ancient geometry. This selection Lord Stanhope printed at his own expense.

"The life of a literary man rarely teems with anecdote; and a mathematician, devoted to his studies, is perhaps more abstracted than any other person from the ordinary occurrences of life, and even the ordinary topics of conversation. Dr. Simson was of this class; and having never married, lived entirely a college life. Having no occasion for the commodious house to which his place in the university entitled him, he contented himself with chambers, good indeed, and spacious enough for his sober accommodation, and for receiving his choice collection of mathematical writers, but without any decoration or commodious furniture. His official servant sufficed for valet, footman, and chambermaid. As this retirement was entirely devoted to study, he entertained no company in his chambers, but in a neighbouring house, where his apartment was sacred to him and his guests. Having in early life devoted himself to the restoration of the works of the ancient geometers, he studied them with unremitting attention; and retiring from the promiscuous intercourse of the world, he contented himself with a small society of intimate friends, with whom he could lay aside every restraint of ceremony or reserve, and indulge in all the innocent frivolities of life. Every Friday evening was spent in a party at whist, in which he excelled, and took delight in instructing others, till increasing years made him less patient with the dulness of a scholar. The card-party was followed by an hour or two dedicated solely to playful conversation. In like manner, every Saturday he had a less select party to dinner at a house about a mile from town. The Doctor's long life gave him occasion to see the dramatis personæ of this little theatre several times completely changed, while he continued to give it a personal identity; so that, without any design or wish of his own, it became, as it were, his own house and his own family, and went by his name. Dr. Simson was of an advantageous stature, with a fine countenance; and even in his old age had a graceful carriage and manner, and always, except when in mourning, dressed in white cloth. He was of a cheerful disposition; and though he did not make the first advances to acquaintance, had the most affable manner, and strangers were at perfect ease in his company. He enjoyed a long course of uninterrupted health, but towards the close of life suffered from an acute disease, and was obliged to employ an assistant in his professional labours for a few years preceding his death, which happened in 1768, at the age of eighty-one. He left to the university his valuable library, which is now arranged apart from the rest of the books, and the public use of it is limited by particular rules. It is considered as the most choice collection of mathematical books and manuscripts in the kingdom, and many of them are rendered doubly valuable by Dr. Simson's notes." For a more particular account of the life and writings of this great man, the reader is referred to the article in the Encyclopedia Britannica, vol. xvii.

SINAPIS, in botany, *mustard*, or *charlock*, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ or Cruciformes. Cruciferæ, Jussieu. Essential character: calyx spreading; corolla claws erect; gland between the shorter stamens and pistil, and between the longer stamens and calyx. There are nineteen species.

SINE, or *right* SINE *of an arch*, in trigonometry, is a right line drawn from one end of that arch, perpendicular to the radius drawn to the other end of the arch; being always equal to half the chord of twice the arch. See TRIGONOMETRY.

SINECURES, ecclesiastical benefices without cure of souls. No church, where there is but one incumbent, can properly be a sinecure: and though the church being down, or the parish being become destitute of parishioners, the incumbent may be thereby necessarily acquitted from the actual performance of public

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duty; yet he is still under an obligation to do it whenever a church shall be built, and there are a competent number of inhabitants: and, in the mean time, if the church be presentative, as most such churches are, the incumbent is instituted into the cure of souls; such benefices are rather depopulations than sinecures, and it will be proper for the new incumbent to read the thirty-nine articles, and the liturgy, in the church-yard, &c. and to do whatever other incumbents usually do. But a rectory, or portion of it, may properly be a sinecure, if there be a vicar under the rector, endowed and charged with the cure, in which case it does not come within the statute of pluralities. 21 Henry VIII. c. 13. Here, therefore, no dispensation is necessary to hold the sinecure with a former living, nor need the incumbent read the articles, or divine service, as required by 13 Elizabeth, c. 12, which extends only to a benefice with cure. By the above-mentioned statute of Henry VIII. not only prebends and rectories, with vicarages endowed, but deaneries, and arch-deaneries, are declared to be benefices without cure.

SINGING, the art of producing with the voice the sounds of any melody, together with the words to which that melody is set. To perform this with justness and good effect, a fine voice, sensible ear, great natural taste, and a knowledge in the science of music, are indispensable requisites.

SINGULAR *number*, in grammar, that number of nouns and verbs which stands opposed to plural; and is used when we only speak of a single on one person, or thing.

SINISTER, in heraldry. The sinister side of an escutcheon is the left hand side; the sinister chief, the left angle of the chief; the sinister base, the left hand part of the base.

SINKING FUND, a portion of the public revenue set apart, to be applied to the reduction or discharge of the public debts. The appropriation of a part of the revenue to this purpose is a measure which had been adopted in other countries long before any necessity for it existed in England, a provision of this kind having been established in Holland in 1655, and in the Ecclesiastical State in 1685. Both these funds originated in a reduction of the interest payable on the public debts, which was the means afterwards adopted for the establishment of a similar fund in this country.

At the commencement of the funding system, the loans were chiefly raised on terminable annuities, which are in themselves a species of sinking fund; but when the present mode of borrowing on perpetual annuities was preferred, it soon became evident, that a continual accumulation of public debts would in time involve the government in much embarrassment, if it was not attended with still worse consequences. Various projects were therefore offered for the discharge of the public debts, or for confining them within moderate bounds; and, among others, the plan of such a sinking fund, as was afterwards actually established, was clearly laid down in a pamphlet, entitled "A Letter to a Member of the late Parliament, concerning the Debts of the Nation," published in 1701. In 1713, Mr. A. Hutcheson presented to the King a plan for payment of the public debts. In 1715, different projects for this purpose were published by Edward Leigh, Mr. Asgill, and others. And, in 1716, a plan for the gradual discharge of the debt was actually adopted, which was afterwards generally known by the appellation of the sinking fund. Sir Robert Walpole claimed great merit as the father of this fund, though it certainly required very little knowledge or invention to copy a plan, which had been found successful in other countries, and which had been publicly recommended many years before; but whatever claims Sir R. Walpole might have to the formation of the plan, he indisputably has all the disgrace of having perverted and destroyed it. The act by which it was established was worded as strong as possible, and expressly ordained, that the fund should be applied to the discharge of the public debts, and to no other use or purpose whatsoever; but, in 1722, it was made a collateral security for the interest of a million raised on exchequer bills, which prepared the way for more direct encroachments. In 1724, a sum was taken from the fund to make good the loss to the treasury from the reduction of the value of gold coin; and in 1727, the whole produce of the civil list revenues were settled on the King, by which the sinking fund was deprived of about 100,000*l.* per annum, to which the surplus of these revenues had usually amounted. In 1733, the gross sum of half a million was taken from the fund towards the current supplies, at which time the medium annual produce of the fund for five years had been 1,212,000*l.*; but the alienation of it being continued, by charging it with the interest of new

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loans, taking sums from it towards the supplies, and even anticipating its produce, little progress was made in the reduction of the debt, and at length the sinking fund became a mere nominal distinction.

The ruinous tendency of a continual accumulation of public debts was strongly pointed out by various writers on subjects of policy and finance; but by none with more zeal and ability than the late Dr. Price, who, about the year 1769, offered to the public some observations on the national debt, in the third chapter of his "Observations on Reversionary Payments," in which he particularly recommended the establishment of a permanent sinking fund, on the principle of that established by Sir Robert Walpole, but of which the efficacy had been so soon destroyed. In 1771, in an "Appeal to the Public on the Subject of the National Debt," he showed that the best scheme for paying off the debt was that which had long been known, which had been adopted, but unhappily crushed in its infancy; and in 1773, in the preface to the third edition of his "Treatise on Reversionary Payments," he took the opportunity of again enforcing the necessity of restoring the plan formerly established, and securing it from future perversion. This advice was repeatedly urged on subsequent occasions; and in 1785, when Mr. Pitt was deliberating on the best means of establishing a new sinking fund, he particularly sought the advice and assistance of Dr. Price, who communicated three plans, which appeared to him the best adapted for carrying into execution a measure he had so long and so earnestly recommended. It was one of the three plans thus communicated which was afterwards adopted; but with some alterations, which considerably affected its efficacy, and which it has since been found necessary to correct.

By the act passed in 1786, for establishing the new sinking fund, the annual sum of one million was placed in the hands of commissioners, who are, the Speaker of the House of Commons, the Chancellor of the Exchequer, the Master of the Rolls, the Accomptant General of the Court of Chancery, and the Governor and Deputy Governor of the Bank of England, for the time being, respectively. This million was to be issued in four equal quarterly payments, and to be applied either in paying off such redeemable annuities as shall be at or above par, is such manner as may be directed by future acts of Parliament, or in the purchase of annuities below par at the market price. The dividends on the sums redeemed or purchased, with the annuities for lives or term of years that fall in or expire, and the sums which may be saved by any reduction of interest, were to be added to the fund, which, according to the original act, was to continue thus increasing till it amounted to four millions per annum; which it was then computed would be about the year 1812, when upwards of fifty-six millions of stock would be redeemed. From this time the dividends on such capital as should in future be paid off or purchased by the commissioners, with such annuities as might afterwards fall in, were to be at the disposal of Parliament.

The commissioners were directed by the act to make their purchases "in equal portions, as nearly as may be, on every day (Saturdays and Mondays excepted) on which the same shall be transferable." They were empowered to subscribe towards any public loan, to be raised by an act of Parliament upon perpetual annuities, subject to redemption at par; and on account of the sums issued to them, and of the stock purchased to the first of February in every year, was directed to be annually laid before Parliament on or before the 15th of February. The purchases at first were all made in the 3 per cents. probably with the view of redeeming the 5 per cents. if the state of the public funds should render such a measure practicable, or of inducing the proprietors to agree to a reduction of the interest at the time when they would become redeemable.

On the 17th February, 1792, the minister proposed, for the purpose of accelerating the operation of the fund, that the sum of 400,000*l.* should be issued, in addition to the annual million; and stated that, in consequence of this and future intended additions, it might be expected that twenty-five millions of 3 per cents. would be paid off by the year 1800: and that in the year 1808 the fund would have arisen to four millions per annum, being the sum to which it was restricted by the original act. The accumulation, however, was not to cease till the interest of the capital discharged, and the amount of expired annuities, should, together with the annual million only, and exclusive of the proposed additions, amount to four millions. But the most important improvement was a provision, that whenever in future any sums shall be raised

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by loans, on perpetual redeemable annuities, a sum, equal to one per cent on the stock created by such loans, should be issued out of the produce of the consolidated fund quarterly, to be placed to the account of the commissionsers; and if the loan, or any part, is raised by annuities, for a longer term than forty-five years, or for lives, a computation is to be made of what will be, at the end of forty-five years, the actual value of such part of the annuities as may be then outstanding, and the sum to be placed to the account of the commissioners is to be equal to one per cent. on the computed future value. By this means this immediate progress of the fund was accelerated, and future loans were put into a regular course of redemption.

This appropriation of one per cent. was to form a distinct fund; and a separate account was directed to be kept of the progress of each fund, by which it appeared, that on the first of February, 1802, the original fund had increased to 2,534,187*l.* 1*s.* 9*d.* and the new fund to 3,275.143*l.* 2*s.* 3*d.* It was now deemed expedient to unite the two funds, and to apply the whole amount indiscriminately to the reduction of the total debt. With this view, the former injudicious limitation of a fund established professedly on the principle of compound interest, was done away; the usual annual grant of 200,000*l.* per annum was made a permanent charge upon the consolidated fund; and the whole amount of the sinking fund was directed to be regularly applied to the purchase or redemption of stock, "so as that the whole of the several redeemable public annuities, now charged upon the public funds of Great Britain, shall be paid off within forty-five years from the respective periods of the creation of such respective charges and public annuities."

Particulars of the Sums constituting the Sinking Fund, as it stood on 1st Februrry, 1808.

	£.	s.	d.
Original annual charge	1,000,000	0	0
Additional issue by act of 1802	200,000	0	0
Exchequer annuities, which expired in 1792	54.880	14	6
Short annuities of 1777, which expired in 1787	25,000	0	0
Life annuities fallen in, or unclaimed	49,786	18	1
Dividend on 124,428,213*l.* stock, at 3 per cent.	3,732,846	7	9½
Ditto on 2,617,400*l.* stock, at 4 per cent.	104,696	0	0
Ditto on 142,000*l.* stock, at 5 per cent.	7,100	0	0
One per cent on the principal part of the capitals created since 1st February, 1793	3,491,330	12	10
Appropriation for reduction of the loan of 1807	646,752	5	4½
Total	£ 9,312,392	18	7

Amount of the different descriptions of Stock redeemed.

	£.
Consolidated 3 per cent. annuities	54,912,000
Reduced 3 per cent. annuities	62,611,702
Old and new South Sea annuities	6,901,000
Three per cent. annuities 1751	753,000
Consolidated 4 per cent. annuities	2,617,400
Consolidated 5 per cent. annuities	142,900
Total	£ 127,937,102

The total sum which has been paid for the amount of stock thus bought up was 79,465,877*l.* 0*s.* 10*d.*

The above statement is exclusive of the fund for the reduction of that part of the debt of Ireland which has been funded in Great Britain, by which 4,628,926*l.* 3 per cent. stock has been redeemed; and likewise of the appropriation for the reduction of the Imperial debt, by which, at the

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above period, 829,426*l.* stock had been redeemed.

SINNET, on board a ship, a line or string made of rope yarn, consisting generally of two, six, or nine strings, which are divided into three parts, and are platted over one another, and then beaten smooth and flat with a wooden mallet. Its use is to save the ropes, or to keep them from galling.

SINUATED *leaf.* See BOTANY.

SINUS, denotes a cavity of certain bones, and other parts, the entrance whereof is narrow, and the bottom wider and more spacious.

SINUS, in surgery, a little cavity, or sacculus, frequently formed by a wound or ulcer, wherein pus is collected.

SIPHON, or SYPHON, in hydraulics, a bended pipe, one end of which being put into a vessel of liquor, and the other hanging out of the said vessel over another, the liquor will run out from the first into the last, after the air has been sucked out of the external or lower end of the siphon, and that as long as the liquor in the upper vessel is above the upper orifice of the siphon. See HYDRAULICS.

SIPHONANTHUS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Borragineæ, Jussieu Essential character: corolla one-petalled, funnel form, very long, inferior; berries four, one-seeded. There are two species, *viz.* S. indica, and S. angustifolia, natives of South America.

SIPHONIA, in botany, a genus of the Monoecia Monadelphia class and order. Essential character: calyx one-leafed; corolla none: male, anthers five, growing below the top of the column: female, style none; stigmas three; capsule tricoccous; seed one, sometimes two or three. There is but one species, *viz.* S. elastica, elastic gum tree.

SIPUNCULUS, in natural history, *tube-worm*, a genus of the Vermes Intestina class and order. Body round, elongated: mouth cylindrical at the end, and narrower than the body; aperture at the side. There are two species, *viz.* S. nudus; body covered with a close skin, and globular at the lower end; it inhabits European seas, under stones; and is eight inches long: and S. saccatus; body covered with a loose skin, and rounded at the lower end; this is found in the American and Indian seas; in shape it is like the former, except in being enclosed in a loose bag, and in not having the lower end globular.

SIREN, in natural history, a genus of Amphibia, of the order Reptiles, or of the order Meantes, an order instituted by Linnæus on account of this genus of animals alone. Generic character: body naked, with two feet, and without a tail; feet with arms and nails.

S. lacertina, or the eel-shaped siren, is most nearly allied to the lizard tribe, but differs from it in having only two feet, and those armed with claws; the body is shaped like an eel; its colour is a dark brown, speckled with white; it is often more than two feet long, and inhabits the stagnant waters of South Carolina; sometimes, however, quitting water for the land. This curious animal was discovered by the ingenious Dr. Garden, who presented several specimens of it to Linnæus, and excited the attention and curiosity of that great man, on this particular subject, to so high a degree, that he asserted few things would more gratify him, than a particular knowledge of the nature and habits of a creature so extraordinary. The siren, if thrown with great force upon the ground, will break in several places, resembling, in this instance, a species of the anguis. See Amphibia, Plate II. fig. 2.

S. anguina, or the anguine siren, is a native of a particular lake in Carniola, from which the water regularly drains off during the summer; during which time the bottom produces corn, or pasture. In autumn, the water returns with considerable rapidity, flowing principally from springs in the neighbouring mountains. In this lake, this siren is found of the length of eleven inches, and of a pale rose colour. It has both fore and hind legs. Its movements are extremely slow and weak when it is placed in a vessel, whether with or without water; but in its native situation it is far more active. It is, by some, supposed to be the larva of a lizard, and by others imagined to be a complete animal. Its habits are predatory, and it subsists on the smaller inhabitants of the water.

S. pisciformis, or the fish-formed siren, is concluded to be a native of Mexico. In its general appearance it greatly resembles the larva of the paradoxical frog; it possesses, however, gills with outward openings, and thus resembles a fish. The feet are unfurnished with the slightest degree of web. Shaw appears strongly inclined to the idea of its being the tadpole, or larva of some large lizard.

SIREX, in natural history, *tailed-wasp.* Mouth with a thick, horny, truncate, short, denticulate mandible; four feelers, the hind ones longer and thicker upwards;

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antennæ filiform, of more than twenty-four equal articulations; sting exserted, serrate, stiff; abdomen sessile, terminating in a point; wings lanceolate, incumbent, the lower ones shorter. There are twenty-six species. The larvæ of this genus are six-footed, soft and cylindrical; the head rounded; they perforate wood, and frequently eat their way into the bowels of other insects, and their larvæ living upon and consuming their vitals; the pupa folliculate: the perfect insect lives on the nectar of flowers. The largest species is S. gigas, which surpasses the hornet in size, and is principally observed in the neighbourhood of pines; it is black, with the eyes, the base, and lower half of the abdomen bright orange yellow. The larva inhabits decayed pines and firs. It changes to a chrysalis in July, first enveloping itself in a slight silken web, of a whitish colour; the chrysalis is of a lengthened shape, with antennæ, legs, and tube, very distinctly characterized. If the change of chrysalis takes place in summer, the fly proceeds from it in about three weeks: but if at the close of autumn, the animal continues in the chrysalis state the whole winter. The male is much smaller than the female: the eggs are deposited by the female in the decayed parts of trees. See Plate IV. Entomology, fig. 5.

SIRIUS, the *dog-star*; a very bright star of the first magnitude, in the mouth of the constellation Canis Major, or the Great Dog This is the brightest of all the stars in our firmament; and therefore, probably, says Dr. Maskelyne, the astronomer royal, the nearest to us of them all. Some, however, suppose Arcturus to be the nearest. This is one of the earliest named stars in the whole heavens. Hesiod and Homer mention only four or five constellations, or stars, and this is one of them. Sirios and Orion, the Hyades, Pleiades, and Arcturus, are almost the whole of the old poetical astronomy. The three last the Greeks formed of their own observation, as appears by the names; the two others were Egyptian. Sirius was so called from the Nile, one of the names of that river being Siris; and the Egyptians seeing that river begin to swell at the time of a particular rising of this star, paid divine honours to this star, and called it by a name derived from that of the river, expressing the star of the Nile.

SIROCCO, a periodical wind which generally blows in Italy and Dalmatia every year about Easter. It blows from the south-east by south; it is attended with heat, but not rain; its ordinary period is twenty days, and it usually ceases at sunset. When the sirocco does not blow in this manner, the summer is almost free from westerly winds, whirlwinds, and storms. This wind is prejudicial to plants, drying and burning up their buds; though it hurts not men any otherwise than by causing an extraordinary weakness and lassitude: inconveniences that are fully compensated by a plentiful fishing, and a good crop of corn on the mountains. In the summer time, when the westerly wind ceases for a day, it is a sign that the sirocco will blow the day following, which usually begins with a sort of whirlwind.

SISON, in botany, *hone-wort*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: involucres mostly four-leaved; fruit ovate, striated. There are seven species.

SISYMBRIUM, in botany, *water-cress*, or *water-rocket*, a genus of the Tetradynamia Siliquosa, class and order. Natural order of Siliquosæ Cruciformes, or Cruciferæ. Essential character; silique opening with straightish valves; calyx and corolla spreading. There are fifty-three species.

SISYRINCHIUM, in botany, a genus of the Monadelphia Triandria class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: spathe two, leaved; calyx none; petals six, almost equal; style none: capsule three-celled, inferior. There are ten species.

SITE, or Scite, denotes the situation of an house, messuage, &c. and sometimes the ground-plot, or spot of earth it stands on. In logic, situs is one of the predicaments declaring a subject to be so and so placed: and in geometry and algebra, it denotes the situation of lines, surfaces, &c.

SITTA, the *nut-hatch*, in natural history, a genus of birds of the order Picæ. Generic character; bills straight; upper mandible a little longer; nostrils small, and covered with bristles; tongue short, jagged, and horney at the tip; four toes, the back one as large as the middle fore one. Latham notices seven species, and Gmelin twelve. The following is the principal: S. Europea, or the European nut-hatch. This bird weighs about an ounce. Its manners much resemble those of the woodpecker, in whose deserted nests it often builds. When the female is in a state of incubation, if she be at all annoyed by the touch of

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a stick, she will utter a violent kind of serpent-like hiss. She is supplied with food in ample abundance, during her sitting, by the most active assiduity of her companion. The food of these birds consists of caterpillars, and all sorts of beetles and insects, as well as nuts, the last of which they are said to hoard; and they crack them by the stroke of their bill with extreme dexterity. They run up and down trees, in restless pursuit, like the woodpecker. They are not migratory from England, but, like many other birds, change their haunts, from the open country, as winter approaches, to reside during the cold season in gardens, orchards, and other warm inclosures. In a state of confinement, they rarely perch like other birds; and almost always sleep standing on the flooring of their cage

SIUM, in botany, *water-parsnep*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: involucre many-leaved; petals cordate; fruit sub-ovate, striated. There are nineteen species.

SIZE, is a sort of glue, used by painters, &c. The shreds and pairings of leather, parchment, or vellum, being boiled in water and strained, make size. This substance is used in many trades. Mr. Boyle mentions, among other uses, that fine red stands and hanging shelves, are coloured with ground vermilion tempered with size, and when dry are laid over with common varnish. There is also a size made of isinglass, in the same manner, and for the like purposes; but this size will not keep above three or four days, so that no more should be made of it at once than the present occasion requires.

The manner of using size is, to melt some of it over a gentle fire, and scraping as much whiting into it as may only colour it, let them be well incorporated together; after which you may whiten frames &c. with it. After it dries, melt the size again, and put more whiting, and whiten the frames, &c. seven or eight times, letting it dry between each time: but before it is quite dry between each washing, you must smooth and wet it over with a clean brush pencil in fair water

SKAITE, in ichthyology, the variegated raia with the middle of the back smooth, and one row of spines on the tail. See RAIA.

SKATING, an exercise on ice, both graceful and healthy. Although the ancients were remarkable for their dexterity in most of the athletic sports, yet skating seems to have been unknown to them. It may therefore be considered as a modern invention, and probably it derived its origin in Holland, where it was practised not only as a graceful and elegant amusement, but as an expeditious mode of travelling when the lakes and canals were frozen up during winter. In Holland long journeys are made upon skates with ease and expedition; but in general less attention is there paid to graceful and elegant movements, than to the expedition and celerity of what is called journey skating. It is only in those countries where it is considered as an amusement, that its graceful attitudes and movements can be studied; and there is no exercise whatever better calculated to set off the human figure to advantage. The acquirement of most exercises may be attained to an advanced period of life; but to become an expert skater, it is necessary to begin the practice of the art at a very early age. It is difficult to reduce the art of skating to a system. It is principally by the imitation of a good skater that a young practitioner can form his own practice. Those who wish to be proficients should begin at an early period of life, and should first endeavour to throw off the fear which always attends the commencement of an apparently hazardous amusement. They will soon acquire a facility of moving on the inside; when they have done this, they must endeavour to acquire the movement on the outside of the skates, which is nothing more than throwing themselves upon the outer edge of the skate, and making the balance of their body tend towards that side, which necessarily enables them to form a semicircle. In this much assistance may be derived from placing a bag of lead shot in the pocket next to the foot employed in making the outside stroke, which will produce an artficial poise of the body, which afterwards will become natural by practice. At the commencement of the outside stroke, the knee of the employed limb should be a little bended, and gradually brought to a rectilinear position when the stroke is completed. When the practitioner becomes expert in forming the semicircle with both feet, he is then to join them together, and proceed progressively and alternately with both feet, which will carry him forward with a graceful movement

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Care should be taken to use very little muscular exertion, for the impelling motion should proceed from the mechanical impulse of the body thrown into such a position as to regulate the stroke. At taking the outside stroke, the body ought to be thrown forward easily, the unemployed limb kept in a direct line with the body, and the face and eyes directly looking forward: the unemployed foot ought to be stretched towards the ice, with the toes in a direct line with the leg. In the time of making the curve, the body must be gradually, and almost imperceptibly, raised, and the unemployed limb brought in the same manner forward; so that, at finishing the curve, the body will bend a small degree backward, and the unemployed foot will be about two inches before the other, ready to embrace the ice, and form a correspondent curve. The muscular movement of the whole body must correspond with the movement of the skate, and should be regulated so as to be almost imperceptible to the spectators. Particular attention should be paid in carrying round the head and eyes with a regular and imperceptible motion; for nothing so much diminishes the grace and elegance of skating as sudden jerks and exertions, which are too frequently used by the generality of skaters. The management of the arms likewise deserves attention. There is no mode of disposing of them more gracefully in skating outside, than folding the hands into each other, or using a muff.

SKELETON, in anatomy, an assemblage or arrangement of all the bones of a dead animal, dried, cleansed, and disposed in their natural situation, and kept in that order by means of wires, &c.

Skeleton, *natural*. This is so termed in opposition to an artificial skeleton, when the bones are retained in their proper places by their natural ligaments, which are dried upon the articulations. Natural skeletons of frogs, mice, birds, and other small animals, are easily made, by putting them into a box, perforated with holes, and burying them in or near a large ant hill. The larger the species of ant, the more quickly will the work be performed. These animals will completely remove the muscular parts, and leave the skeleton in the posture in which it was originally placed.

SKIFF, or Skuff, the least of two ship's boats, serving chiefly to go ashore in, when the ship is in harbour.

SKIMMIA, in botany, a genus of the Tetrandria Monogynia class and order. Essential character; calyx four-parted; petals four, concave; berry four-seeded. There is but one species, *viz.* S. japonica, a native of Japan near Nagasaki.

SKIN. See Cutis.

SKINNER, one who works in skins.

SKIRMISH, in war, a disorderly kind of combat or encounter, in presence of two armies, between small parties or persons, who advance from the body for that purpose, and introduce a general and regular fight. See Tactics.

SKULL, in anatomy, that part of the head which forms its great bony cavity; and in a living subject contains the brain. See Anatomy.

SKY, the blue expanse of air and atmosphere. The azure colour of the sky Sir Isaac Newton attributes to vapours beginning to condense there, and which have got consistence enough to reflect the most reflexible rays.

SLAG, is a term used by the persons employed in working minerals, to express any hard vitrescent generally coloured opaque mass, produced by the fusion of any stony or metallic mixture. It generally consists of the matrix of the ore, and any saline or earthy flux that may have been used. The slag of iron founderies is for the most part composed of the earthy part of the ore, of the lime used as a flux, and the whole coloured with a part of the oxide of iron. Slag differs from scoria, in being more dense, and more completely vitrified; whereas the scoria, or dross, is lighter and porous. When the slag is very opaque and heavy, it contains a considerable quantity of metal, and in that case it may be worth while to work it over again. Slag in many parts of the country is used for mending roads, for which it makes a capital material when a little worn down, being hard, and almost impenetrable by water.

SLATE, a well known, neat, convenient and durable material, for the covering of the roofs of buildings. There are great varieties of this substance, and it likewise differs very greatly in its qualities and colours In some places it is found in thick laminæ or flakes, while in others it is thin and light. The colours are white, brown, and blue. It is so durable in some cases, as to have been known to continue sound and good for centuries. However, unless it should be brought from a quarry of well reputed goodness, it is necessary to try its properties, which may be done by

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striking the slate sharply against a large stone, and if it produce a complete sound, it is a mark of goodness; but if, in hewing, it does not shatter before the edge of the sect, or instrument commonly used for that purpose, the criterion is decisive. The goodness of the slate may be further estimated by its colour: the deep black blue is apt to imbibe moisture, but the lighter blue is always the least penetrable: the touch also may be in some degree a guide, for a good firm stone feels somewhat hard and rough, whereas an open slate feels very smooth, and as it were greasy. And another method of trying the goodness of slate is, to place the slate-stone lengthwise, and perpendicular in a tub of water, about half a foot deep, care being taken that the upper or unimmersed part of the slate be not accidentally wetted by the hand or otherwise: let it remain in this state twenty-four hours; if good and firm stone, it will not draw water more than half an inch above the surface of the water, and that perhaps at the edges only, those parts having been a little loosened in the hewing; but a spongy defective stone will draw water to the very top. There is still another mode, held to be infallible. First weigh two or three of the most suspected plates, noting the weight; then immerge them in a vessel of water twelve hours, take them out, and wipe them as clean as possible with a linen cloth, and if they weigh more than at first, it denotes that quality of slate which imbibes water; a drachm is allowable in a dozen pounds, and no more. In the laying of this material, a bushel and a half of lime, and three bushels of fresh water sand will be sufficient for a square of work, but if it be pin plastered, it will take above as much more: but good slate, well laid, and plastered to the pin, will lie an hundred years, and on good timber a much longer time. It has been common to lay the slates dry, or on moss only. When they are to be plastered to the pin, then about the first quantity of lime and sand will be sufficient for the purpose.

See THONSCHIEFER.

SLAVES and SLAVERY. Pure and proper slaves do not, nay cannot, subsist in England; such, that is, whereby an absolute and unlimited power is given to the master over the life and fortune of the slave, and indeed it is repugnant to reason, that such a state should subsist any where; and the law of England abhors, and will not endure, the existence of slavery within this nation; so that when an attempt was made to introduce it by statute 1 Edward VI. cap. 3, which ordained, that all idle vagabonds should be made slaves, and fed upon bread and water, on small drink, and refuse meat, should wear a ring of iron round their necks, arms, or legs, and should be compelled, by beating, chaining, or otherwise, to perform the work assigned them, were it never so vile; the spirit of the nation could not brook this condition, even in the most abandoned rogues; and therefore this statute was repealed in two years afterwards, by statute 3 and 4 Edward VI. cap. 16. And now it is laid down, that a slave or negro, the instant he lands in England, becomes a free man, that is, the law will protect him in the enjoyment of his person and his property. Yet, with regard to any right which the master may have lawfully acquired to the perpetual service of John, or Thomas, this, says Blackstone, will remain exactly in the same state as before: [what that right is not, we shall presently see]: hence too it follows, that the infamous and unchristian practice of withholding baptism from negro servants, lest they should thereby gain their liberty, is totally without foundation, as well as without excuse. The law of England acts upon general and extensive principles: it gives liberty, rightly understood, that is, protection to a Jew, a Turk, or a Heathen, as well as to those who profess the true religion of Christ; and it will not dissolve a civil obligation between master and servant, on account of the alteration of faith in either of the parties; but the slave is entitled to the same protection in England before, as after, baptism; and whatever service the Heathen negro owed of right to his American master, by general not by local law, the same (whatever it be) is he bound to render, when brought to England and made a Christian.

In the celebrated case of James Somersett, it was decided, that a Heathen negro, when brought to England, owes no service to an American, or any other master. James Somersett had been made a slave in Africa, and was sold there; from thence he was carried to Virginia, where he was bought, and brought by his master to England.

Here he ran away from his master, who seized him and carried him on board a ship, where he was confined, in order to be sent to Jamaica to be sold as a slave. Whilst he was thus confined, a habeas corpus was granted, ordering the captain of the ship "to bring up the body of James Somersett, with the cause of his

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detainer:" the above mentioned circumstances being stated on the return to the writ, after much discussion in the Court of King's Bench, the court were unanimously of opinion, that the return was insufficient, and that Somersett ought to be discharged.

In consequence of this decision, if a ship laden with slaves was obliged to put into an English harbour, all the slaves on board might (and Mr. Christain says ought to) be set at liberty. Though there are acts of parliament which recognise and regulate the slavery of negroes, yet it exists not in the contemplation of the common law: and the reason they are not declared free before they reach an English harbour is, only because their complaints cannot sooner be heard and redressed by the process of an English court of juctice.

Liberty, by the English law, depends not on the complexion; and what was said even in the time of Queen Elizabeth is now substantially true, that the air of England is too pure for a slave to breathe in.

By stature 30 George III. c. 33, (continued and amended by statute 31 George III. c. 54, 32 George III. c. 52, and subsequent acts; and explaining and amending a former statute of 20 George III. c. 66.) several humane provisions were made to restrain the cruelties practised in the African slave trade, bounties were given to the masters and surgeons of ships delivering the slaves well at their destined port, &c. This, perhaps, was a happy prelude to the abolition of that detestable commerce, which has been so gloriously accomplished. See also statute 35 George III. c. 90: and the Journals of the House of Commons.

An African company was also established by statute 31 George III. c. 55, for carrying on a trade between Great Britain and the coasts and countries of Africa; and a colony was for that purpose established on the peninsula of Sierra Leone. This company was intended to supersede, in time, the necessity of the African slave trade, by raising sugars there by native Africans; it being one of the conditions of the act, that the company shall not deal in nor employ slaves. The company is to last for thirty-one years from July 1st, 1791. At length, as a last act of the administration to which Mr. Fox had belonged, the abolition of the slave trade, as respects the subjects of Great Britain, and her colonies, was effected by act of parliament in the year 1807. May this brilliant example of justice be followed by other nations

SLEDGE, a kind of carriage without wheels, for the conveyance of very weighty things, as huge stones, &c.

This is also the name of a large smith's hammer to be used with both hands. Of this there are two sorts. The uphand-sledge, which is used by under workmen when the work is not of the larger sort; it is used with the hands before, and they seldom raise it higher than their head; but the other, which is called the about-sledge, and which is used for battering or drawing out the largest work, is held by the handle with both hands, and swung round over their heads, at their arms' end, to strike as hard a blow as they can.

SLEEPERS, in a ship, timbers lying before and aft, in the bottom of the ship, as the rung-heads do: the lowermost of them is bolted to the rung-heads, and the uppermost to the futtocks and rungs.

SLING, an instrument serving for casting stones with great violence. The inhabitants of the Balearic islands were famous in antiquity for the dextrous management of the sling; it is said they bore three kinds of slings, some longer, others shorter, which they used according as their enemies were either nearer or more remote. It is added, that the first served them for a head-band, the second for a girdle, and that a third they constantly carried with them in the hand.

Slings *of a yard*, ropes fixed round the middle, and serving to suspend it, for the greater ease of working, or for security in an engagement; in the latter case they usually add iron chains to the slings of the lower yards. Boat slings are strong ropes, furnished with hooks and iron thimbles, by which to hook the tackle, in order to hoist the boats in or out of the ship; the hooks of the slings are applied to ring bolts fixed in the keel, and extremities of the boat.

SLINGING is used variously at sea, but chiefly for the hoisting up casks, or other heavy things, with slings, *i. e.* contrivances of ropes spliced into themselves, at either end, with one eye big enough to receive the cask, or other thing, to be slung.

SLOANEA, in botany, so named in memory of Sir Hans Sloane, Bart. a genus of the Polyandria Monogynia class and order. Natural order of Amentaceæ. Tiliaceæ, Jussieu. Essential character, calyx, one-leaved, from five to nine cleft; corolla none; anthers growing to the filaments, below the top; capsule echi-

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nate, from three to six celled, from three to six valved; seeds two, in a berried aril There are three species.

SLOATH, or SLOTH See BRADYPUS.

SLOOP, in naval affairs, a small vessel, furnished with one mast, the main sail of which is attached to a gaff above, to the mast on its foremost edge, and to a boom below; it differs from a cutter by having a fixed steering bow-sprit, and a jib-stay: the sails also are less in proportion to the size of the vessel. Sloops of war, are vessels commanded by officers in a middle rank, between a lieutenant and a post captain: these are styled masters and commanders. They carry from ten to eighteen guns, and are variously rigged as ships, brigs, schooners, and sometimes cutters.

SLUICE, in hydraulics, a frame of timber, stone, earth, &c. serving to retain and raise the water of the sea, a river, &c. and on occasion to let it pass: such is the sluice of a mill, which stops and collects the water of a rivulet, &c. in order to discharge it at length, in greater plenty, upon the mill wheel: such also are those used in drains, to discharge water off lands; and such are the sluices of Flanders, &c. which serve to prevent the waters of the sea overflowing the lower lands, except when there is occasion to drown them. Sometimes there is a canal between two gates or sluices, in artificial navigation, to save the water, and render the passage of boats equally easy and safe, upwards and downwards; as in the sluices of Briare, in France, which are a kind of massive walls, built parallel to each other, at the distance of twenty or twenty-four feet, closed with strong gates at each end, between which is a kind of canal or chamber, considerably longer than broad, wherein a vessel being inclosed, the water is let out at the first gate, by which the vessel is raised fifteen or sixteen feet, and passed out of this canal into another much higher. By such means a boat is conveyed out of the Loire into the Seine, though the ground between them rise above one hundred and fifty feet higher than either of those rivers.

The construction of sluices ought to be conducted by an able engineer, who is well acquainted with the action of fluids in general: and particularly with the situation of the place, the nature of the soil, &c. where the sluice is to be erected; if on the sea-shore, he ought to be perfectly well acquainted with the effects of the sea on that coast, and the seasons when it is calm or stormy, that he may be able to prevent the fatal accidents thence arising: and if in a river, it is necessary to know whether it usually overflows its banks, and at what seasons of the year its waters are highest and lowest. The machines for driving the piles should be placed about forty yards from the side of the sluice, above and below it. As to the depth of sluices, it must be regulated by the uses for which they are designed; thus, if a sluice is to be erected at the entrance of a basin for shipping, its depth must correspond with the draught of water of the largest ship that may, at any time, have occasion to enter thereby. The rule usually observed is, to make the surface of the bottom of the canal on a level with the low-water-mark: but if the bottom of the harbour and canal be such, as to be capable of becoming deeper by the action of the water, Belidor very justly observes, that the bottom of the sluice-work should be made deeper than either.

When a sluice is to be placed at the bottom of an harbour, in order to wash away the filth that may gather in it, by means of the waters of a river or canal, in this case the bottom of the sluice-work should be two feet or eighteen inches higher than the bottom of the harbour, that the water may run with the greater violence.

An engineer ought always to have in his view, that the faults committed in the construction of sluices are almost always irreparable. We shall therefore lay down some rules, from Belidor, for avoiding any oversight of this kind: 1 In order to adjust the level of the sluice-work with the utmost exactness, the engineer ought to determine how much deeper it must be than a fixed point: and this he should mark down in his draught, in the most precise terms possible. 2. When the proper depth is settled, the foundation is next to be examined: and here the engineer cannot be too cautious, lest the apparent goodness of the soil deceive him: if the foundation be judged bad, or insufficient to bear the superstructure, it must be secured by driving piles, or a grate-work of carpentry. 3. There should be engines enough provided for draining the water, and these should be entirely under the direction of the engineer, who is to take care that they be so placed as not to be an obstacle to the work; and also cause proper trenches to be cut, to convey the water clear off from the foundation. 4. When the sluice

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is to be built in a place where the workmen will be unavoidably incommoded by the waters of the sea, &c. all the stones for the mason-work, as well as the timbers for that of carpentry, should be prepared before-hand; so that when a proper season offers for beginning the work, there remains nothing to be done, but to fix every thing in its place. 5. In order to show the state of the work, an exact journal should be kept of the materials employed, to be signed every week by the chief engineer and undertaker; observing to distinguish the different pieces of materials, and the places where they were employed. 6. When an undertaker is found, who is not only able to be at the expense of providing all the materials, but likewise vigilant and active to execute whatever is judged necessary for the perfection of the work, it would be the worst of policy to give the preference to others, who, through ignorance, or dishonesty, bring in estimates lower than it is possible to execute the work as it ought. However, that the conditions of the contract may be properly executed, the chief engineer, or other persons of unquestionable understanding and honesty, commissioned for that purpose, should take care that able workmen be employed, and that they execute their several parts in a proper manner.

Sluices are made different ways, according to the uses they are intended for: when they serve for navigation, they are shut with two gates, presenting an angle towards the stream; but when made near the sea, there are two pairs of gates, one to keep the water out, and the other to keep it in, as occasion requires: the pair of gates next the sea present an angle that way, and the other pair the contrary way; the space inclosed by these gates is called a chamber. When sluices are designed to detain the water in some parts of the ditch of a fortress, they are made with shutters to slide up and down in grooves; and when they are made to cause an inundation, they are then shut by means of square timbers let down into cullises, so as to lie close and firm. Particular care must be taken, in the building of a sluice, to lay the foundation in the securest manner possible; to lay the timber-grates and floors in such a manner, that the water cannot penetrate through any part, otherwise it will undermine the work; and, lastly, to make the grates of a proper strength, in order to support the pressure of the water; and yet to use no more timber than is necessary.

SMACK, a small vessel with but one mast. Sometimes they are employed as tenders on a man of war, and are used for fishing upon the coast, &c.

SMALT, a kind of glass of a dark-blue colour, which, when levigated, appears of a most beautiful colour, and, if it could be made sufficiently fine, would be an excellent succedaneum for ultramarine, as not only resisting all kinds of weather, but even the most violent fires. It is prepared by melting one part of oxide of cobalt with two of flint-powder, and one of potass. At the bottom of the crucibles in which the smalt is manufactured, we generally find a regulus, of a whitish colour, inclining to red, and extremely brittle. This is melted afresh, and, when cold, separates into two parts; that at the bottom is the cobaltic regulus, which is employed to make more of the smalt; the other is bismuth.

SMARAGDITE, in mineralogy. This stone was called smaragdite, by M. Saussure, from some resemblance which it has to the emerald. Never crystallized. Its texture is foliated. Easily divided into plates. The laminæ are inflexible. Fracture even. Specific gravity 3. Colour, in some cases, fine green; in others it has the grey colour and metallic lustre of mica: it assumes all the shades of colour between these two extremes.

SMEATON, (John,) in biography, an eminent civil engineer, was born the 28th of May, 1724, O. S. at Austhorpe, near Leeds, in a house built by his grandfather, and where his family have resided ever since. The strength of his understanding and the originality of his genius appeared at an early age; his playthings were not the playthings of children, but the tools which men employ; and he appeared to have greater entertainment in seeing the men in the neighbourhood work, and asking them questions, than in any thing else. One day he was seen, to the distress of his family, on the top of his father's barn, fixing up something like a windmill. Another time he attended some men fixing a pump at a neighbouring village, and observing them cut off a piece of bored pipe, he was so lucky as to procure it, and he actually made with it a working pump that raised water. These anecdotes refer to circumstances that are said to have happened while he was in petticoats, and most likely before he attained his sixth year.

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About his fourteenth and fifteenth year he had made for himself an engine for turning, and wrought several presents for his friends of boxes in ivory or wood, very neatly turned. He forged his iron and steel, and melted his metal; he had tools of every sort, for working in wood, ivory, and metals. He had made a lathe, by which he had cut a perpetual screw in brass, a thing little known at that day, which was the invention of Mr. Henry Hindley, of York, with whom Mr. Smeaton soon became acquainted; and they spent many a night at Mr. Hindley's house till day-light, conversing on those subjects. Thus had Mr. Smeaton, by the strength of his genius, and indefatigable industry, acquired, at the age of eighteen, an extensive set of tools, and the art of working in most of the mechanical trades, without the assistance of any master. A part of every day was generally occupied in forming some ingenious piece of mechanism.

Mr. Smeaton's father was an attorney, and desirous of bringing him up to the same profession; Mr. Smeaton therefore came up to London in 1742, and attended the courts in Westminster Hall; but finding, as his common expression was, that the law did not suit the bent of his genius, he wrote a strong memorial to his father on that subject; whose good sense from that moment left Mr. Smeaton to pursue the dictates of his genius in his own way.

In 1751, he began a course of experiments to try a machine of his invention to measure a ship's way at sea, and also made two voyages in company with Dr. Knight, to try it, and a compass of his own invention and making, which was made magnetical by Dr. Knight's artificial magnets. The second voyage was made in the Fortune sloop of war, commanded at that time by Captain Alexander Campbell.

In 1753, he was elected member of the Royal Society: the number of papers published in their Transactions will show the universality of his genius and knowledge.

In 1759, he was honoured by an unanimous vote, with their gold medal, for his paper, entitled "An experimental Inquiry concerning the natural Powers of Water and Wind to turn Mills, and other Machines depending an a circular Motion." This paper, he says, was the result of experiments made on working models in the year 1752 and 1753, but not communicated to the Society till 1759; before which time he had an opportunity of putting the effect of these experiments into real practice, in a variety of cases, and for various purposes, so as to assure the Society he had found them to answer.

In December, 1755, the Eddystone light-house was burnt down. Mr. Weston, the chief proprietor, and the others, being desirous of rebuilding it in the most substantial manner, inquired of the Earl of Macclesfield, then President of the Royal Society, whom he thought the most proper to rebuild it; his Lordship recommended Mr. Smeaton. Mr. Smeaton undertook the work, and completed it in the summer of 1759. Of this Mr. Smeaton gives an ample description, in the volume he published in 1791.

Though Mr. Smeaton completed the building of the Eddystone light-house in 1759, a work that does him so much credit, yet it appears he did not soon get into full business as a civil engineer; for in 1764, while in Yorkshire, he offered himself a candidate for one of the receivers of the Derwentwater estate; and on the thirty-first of December, in that year, he was appointed, at a full board of Greenwich Hospital, in a manner highly flattering to himself, when two other persons, strongly recommended, and powerfully supported, were candidates for the employment. In this appointment he was very happy, by the assistance and abilities of his partner, Mr. Walton, one of the receivers, who, taking upon himself the management and accounts, left Mr. Smeaton leisure and opportunity to exert his abilities on public works, as well as to make any improvements in the mills, and in the estates at Greenwich Hospital. By the year 1775, he had so much business as a civil engineer, that he wished to resign this appointment; and would have done it then, had not his friends, the late Mr. Stewart, the hospital surveyor, and Mr. Ibbetson, their secretary, prevailed upon him to continue in the office about two years longer.

Mr. Smeaton, having now got into full business as a civil engineer, performed many works of general utility. He made the river Calder navigable, a work that required great skill and judgment, owing to the very impetuous floods in that river. He planned and attended the execution of the great canal in Scotland, for conveying the trade of the country either to the Atlantic or German Ocean; and having brought it to the place originally intended, he declined a handsome yearly salary, in

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order that he might attend to the multiplicity of his other business.

On the opening of the great arch at London bridge, the excavation around and under the starlings was so considerable, that the bridge was thought to be in great danger of falling. He was then in Yorkshire, and was sent for by express, and arrived with the utmost dispatch. "I think," says Mr. Holmes, the author of his Life, "it was on a Saturday morning, when the apprehension of the bridge was so general, that few would pass over or under it. He applied himself immediately to examine it, and to sound about the starlings as minutely as he could; and the committee being called together, adopted his advice, which was, to repurchase the stones that had been taken from the middle pier, then lying in Moorfields, and to throw them into the river to guard the starlings." Nothing shows the apprehensions concerning the falling of the bridge more than the alacrity with which this advice was pursued; the stones were repurchased that day; horses, carts, and barges, were got ready, and they began the work on Sunday morning. Thus, Mr. Smeaton, in all human probability, saved London bridge from falling, and secured it till more effectual methods could be taken.

The vast variety of mills which Mr. Smeaton constructed, so greatly to the satisfaction and advantage of the owners, will show the great use which he made of his experiments in 1752 and 1753; for he never trusted to theory in any case, where he could have an opportunity to investigate it by experiment. He built a steam engine as Austhorpe, and made experiments thereon, purposely to ascertain the power of Newcomen's steam engine, which he improved and brought to a far greater degree of perfection, both in its construction and powers, than it was before.

Mr. Smeaton, during many years of his life, was a frequent attendant on parliament, his opinion being continually called for. And here his strength of judgment and perspicuity of expression had their full display. It was his constant custom, when applied to to plan or support any measure, to make himself fully acquainted with it, to see its merits before he would engage in it. By this caution, added to the clearness of his description and the integrity of his heart, he seldom failed to obtain for the bill which he supported an act of parliament. No one was heard with more attention, nor had any one ever more confidence placed in his testimony. In the courts of law he had several compliments paid him from the bench by Lord Mansfield and others, for the new light which he threw on difficult subjects.

About the year 1785, Mr. Smeaton's health began to decline; and he then took the resolution to endeavour to avoid all the business he could, so that he might have leisure to publish an account of his inventions and works, which was certainly the first wish of his heart; for he has often been heard to say, that "he thought he could not render so much service to his country as by doing that." He got only his account of the Eddystone lighthouse completed, and some preparations to his intended Treatise on Mills; for he could not resist the solicitations of his friends in various works: and Mr. Aubert, whom he greatly loved and respected, being chosen chairman of Ramsgate harbour, prevailed upon him to accept the place of engineer to that harbour; and to their joint efforts the public is chiefly indebted for the improvements that have been made there within these few years, which fully appears in a report that Mr. Smeaton gave into the board of trustees in 1791, which they immediately published.

Mr. Smeaton being at Austhorpe, walking in his garden, on the 16th of September, 1792, was struck with the palsy, and died the 28th of October. "In his illness," says Mr. Holmes, "I had several letters from him, signed with his name, but written and signed by another's pen; the diction of them showed that the strength of his mind had not left him. In one written the 26th of September, after minutely describing his health and feelings, he says, 'In consequence of the foregoing, I conclude myself, nine-tenths dead; and the greatest favour the Almighty can do me, as I think, will be to complete the other part; but as it is likely to be a lingering illness, it is only in his power to say when that is likely to happen.'"

Mr. Smeaton had a warmth of expression, that might appear to those who did not know him well to border on harshness; but those more intimately acquainted with him knew that it arose from the intense application of his mind, which was always in the pursuit of truth, or engaged in investigating difficult subjects. He would sometimes break out hastily, when any thing was said that did not tally with his ideas; and he would

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not give up any thing he argued for, till his mind was convinced by sound reasoning. In all the social duties of life he was exemplary; he was a most affectionate husband, a good father, a warm, zealous, and sincere friend, always ready to assist those he respected, and often before it was pointed out to him in what way he could serve them. He was a lover and encourager of merit wherever he found it; and many men are in a great measure indebted to his assistance and advice for their present situation. As a companion, he was always entertaining and instructive; and none could spend any time in his presence without improvement.

As a civil engineer, he was perhaps unrivalled, certainly not excelled by any one, either of the present or former times. His building the Eddystone light-house, were there no other monument of his fame, would establish his character. The Eddystone rocks have obtained their name from the great variety of contrary sets of the tide or current in their vicinity. They are situated nearly S. S. W. from the middle of Plymouth Sound. Their distance from the port of Plymouth is about 14 miles. They are almost in the line which joins the Start and the Lizard Points; and as they lie nearly in the direction of vessels coasting up and down the channel, they were unavoidably, before the establishment of a light-house there, very dangerous, and often fatal to ships. Their situation with regard to the Bay of Biscay and the Atlantic is such, that they lie open to the swells of the bay and ocean, from all the south-western points of the compass; so that all the heavy seas from the south-west quarter come uncontrolled upon the Eddystone rocks, and break upon them with the utmost fury. Sometimes, when the sea is to all appearance smooth and even, and its surface unruffled by the slighted breeze, the ground swell meeting the slope of the rocks, the sea beats upon them in a frightful manner, so as not only to obstruct any work being done on the rock, or even landing upon it, when, figuratively speaking, you might go to sea in a walnut-shell. That a circumstance fraught with danger surrounding it should excite mariners to wish for a light-house, is not wonderful; but the danger attending the erection leads us to wonder that any one could be found hardy enough to undertake it. Such a man was first found in the person of Mr. H. Winstanley, who, in the year 1696, was furnished by the Trinity House with the necessary powers. In 1700 it was finished; but in the great storm of November, 1703, it was destroyed, and the projector perished in the ruins. In 1709, another, upon a different construction, was erected by a Mr. Rudyerd, which, in 1755, was unfortunately consumed by fire. The next building was, as we have seen, under the direction of Mr. Smeaton, who, having considered the errors of the former constructions, has judiciously guarded against them, and erected a building, the demolition of which seems little to be dreaded, unless the rock on which it is erected should perish with it. Of his works, in constructing bridges, harbours, mills, engines, &c. &c. it were endless to speak. Of his inventions and improvements of philosophical instruments, as of the air-pump, the pyrometer, hygrometer, &c. &c. some idea may be formed from the list of his writings. See Hutton's Dict.

SMELL, *sense of.* The sense of smell is very nearly allied to that of taste, and indeed many of those pleasurable sensations which are usually referred to the taste, as being received during the act of eating and swallowing, really belong to the smell. The organ of smell is a membrane or skin, overspread with nerves, which line the internal cavity of the nostrils, and the surface and cavities of the bones which join the nostrils. This is affected both by the odorous particles which proceed from external substances through the nose, and by those which come from the substances which are eaten; for there is a communication between the nose and the back part of the mouth. The pains of smell are obviously designed to assist us in the proper choice of food, and prompt us to avoid such noxious vapours as may render the air injurious to health or life. It appears, also, that offensive odours, in various circumstances, contribute to generate the sense of shame, decency, &c. The pleasures of smell have a direct connection with those of taste. It is only necessary, therefore, to add to what has been said respecting the latter, that the pleasures of smell which arise from the various productions of nature, have a great share in the formation and vividness of some of our mental pleasures; particularly those which arise from the view of rural objects and scenes, and from the representations of them by poetry and painting.

SMELTING, in metallurgy, the fusion

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or melting of the ores of metals, in order to separate the metalline part from the earthy, stony, and other parts. The art of fusing the ores, after roasting, is the principal and most important of metallurgic operations, all the others being preliminary or preparatory to this. The whole attention of the miner is directed towards this process; to this all his efforts are applied, because it affords the truly useful product to which his hopes are directed. Though it consists, in general, in fusing the roasted ore to extract the metal, and in this point of view it seems to present a simple and uniform operation; there is, nevertheless, no operation which differs so much in its circumstances, according to the nature of the metal and the ore required to be treated, and according to the furnaces made use of, the nature and quantity of the combustible employed, the energy, duration, and administration of the fire, the addition of an appropriate flux, the heat being applied in the midst of the coal, or in crucibles, the period, the length of time, and the mode of casting the fused metal; every thing, even the form of the metal which flows out, varies and presents to the observer very remarkable differences.

SMILAX, in botany, a genus of the Dioecia Hexandria class and order. Natural order of Sarmentaceæ. Asparagi, Jussieu. Essential character: calyx six-leaved; corolla none; female, styles three; berry three-celled; seeds two. There are twenty-three species; of these, the S. sarsaparilla, which affords the sarsaparilla root, is the most valuable. This species has stems of the thickness of a man's finger; they are jointed, triangular, and beset with crooked spines; the leaves are alternate, smooth, and shining on the upper side; on the other side are three nerves or costæ, with sundry small crooked spines; the flower is yellow, mixed with red; the fruit is a black berry, containing several brown seeds. Sarsaparilla delights in low moist grounds, and near the banks of rivers. The roots run superficially under the surface of the ground. The gatherers have only to loosen the soil a little, and to draw out the long fibres with a wooden hook. In this manner they proceed till the whole root is got out: it is then cleared of the mud, dried, and made into bundles. The sensible qualities of sarsaparilla are mucilaginous and farinaceous, with a slight degree of acrimony; the latter, however, is so slight, as not to be perceived by many; and it is thought that its medicinal powers may fairly be ascribed to its demulcent and farinaceous qualities. The China, or oriental species of China root, has roundish, prickly stalks, and red berries, and is a native of China and Japan. The pseudo-China, or occidental species, has rounder, smooth stalks, and black berries, grows wild in Jamaica and Virginia, and bears the colds of our own climate. At present the China root is very rarely made use of, having, for some time, given place to sarsaparilla, which is supposed to be more effectual. Prosper Alpinus informs us, that this root is in great esteem among the Egyptian women for procuring fatness and plumpness.

SMITHIA, in botany, so named in honour of James Edward Smith, M. D. P. L. S. a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: legume with distinct, one-seeded joints, connected by the style; stamina divided into two equal bodies. There is only one species, *viz.* S. sensitiva, annual smithia, a native of the East Indies.

SMOKE *jack*, is a very simple and commodious machine in a kitchen; so called, from its being moved by means of the smoke, or rarefied air, moving up the chimney, and striking against the tail of the horizontal wheel, which, being inclined to the horizon, is thereby moved about the axis of the wheel, together with the pinion which carries the wheel, and this carries the chain which turns the spit. The wheel should be placed in the narrow part of the chimney, where the motion of the smoke is swiftest, and the greatest part of it must be made to strike upon the sails.

The manner of operation of this useful machine is easily understood. The air which contributes to the burning of the fuel, and passes through the midst of it, is greatly heated, and expanding prodigiously in bulk, becomes lighter than the neighbouring air, and is therefore pushed by it up the chimney. In like manner, all the air which comes near the fire is heated, expanded, becomes lighter, and is driven up the chimney. This is called the draught or suction; but would, with greater propriety, be termed the drift of the chimney. As the chimney gradually contracts in its dimensions, and as the same quantity of heated air passes through every section of it, it is plain that the rapidity of its ascent must be greatest in the narrowest place. There the fly should be placed, because it

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will there be exposed to the strongest current. This air, striking the fly vanes obliquely, pushes them aside, and thus turns them round with a considerable force. If the joint of meat is exactly balanced on the spit, it is plain that the only resistance to the motion of the fly is what arises from the friction of the pivots of the upright spindle, the friction of the pinion and wheel, the friction of the pivots of the horizontal axis, the friction of the small end of the spit, and the friction of the chain in the two pulleys. The whole of this is but a mere trifle. But there is frequently a considerable inequality in the weight of the meat on different sides of the spit: there must therefore be a sufficient overplus of force in the impulse of the ascending air on the vanes of the fly, to overcome this want of equilibrium, occasioned by the unskilfulness or negligence of the cook.

SMUT, a disease in corn, which destroys entirely the germ and substance of the grain.

SMYRNIUM, in botany, *Alexanders*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: petals acuminate, keeled; fruit oblong, striated. There are seven species.

SNAFFLE, in the manege, is a very slender bit-mouth, without any branches, much used in England; the true bridles being reserved for the service of war.

SNAIL. See Limax.

SNAKE. See Anguis. The common snake is a harmless and inoffensive animal, and might even be kept tame in houses to destroy vermin.

SNAKING, in naval affairs, is the winding small ropes spirally round a large one, the former lying in the intervals between the strands of the latter, and is frequently termed worming.

SNOW, a well known substance, formed by the freezing of the vapours in the atmosphere. It differs from hail and hoar-frost, in being as it were crystallized, which they are not. This appears on examining a flake of snow by a magnifying glass; when the whole of it will appear to be composed of fine shining spicula, diverging like rays from a centre. As the flakes fall down through the atmosphere, they are continually joined by more of these radiated spicula, and thus increase in bulk, like the drops of rain or hail-stones. Dr. Grew, in a discourse on the nature of snow, observes, that many parts thereof are of a regular figure, for the most part stars of six points, and are as perfect and transparent ice as any we see on a pond, &c. Upon each of these points are other collateral points, set at the same angles as the main points themselves: among which there are divers others irregular, which are chiefly broken points, and fragments of the regular ones. Others, also, by various winds, seemed to have been thawed, and frozen again into irregular clusters; so that it seems as if the whole body of snow were an infinite mass of isicles irregularly figured: that is, a cloud of vapours being gathered into drops, the said drops forthwith descend; upon which descent, meeting with a freezing air as they pass through a colder region, each drop is immediately frozen into an isicle, shooting itself forth into several points; but these still continuing their descent, and meeting with some intermitting gales of warmer air, or in their continual waftage to and fro touching upon each other, some of them are a little thawed, blunted, and again frozen into clusters, or entangled so as to fall down in what we call flakes. The lightness of snow, although it is firm ice, is owing to the excess of its surface in comparison to the matter contained under it: as gold itself may be extended in surface till it will ride upon the least breath of air. The whiteness of snow is owing to the small particles into which it is divided; for ice, when pounded, will become equally white. According to Beccaria, clouds of snow differ in nothing from clouds of rain, but in the circumstance of cold that freezes them. Both the regular diffusion of the snow, and the regularity of the structure of its parts, (particularly some figures of snow or hail which fall about Turin, and which he calls rosette,) show that clouds of snow are acted upon by some uniform cause like electricity; and he endeavours to show how electricity is capable of forming these figures. He was confirmed in his conjectures, by observing that his apparatus for observing the electricity of the atmosphere never failed to be electrified by snow as well as rain. Professor Winthrop sometimes found his apparatus electrified by snow when driven about by the wind, though it had not been affected by it when the snow itself was falling. A more intense electricity, according to Beccaria, unites the particles of hail more closely than the more moderate

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electricity does those of snow, in the same manner as we see that the drops of rain which fall from thunder-clouds are larger than those which fall from others, though the former descend through a less space.

Were we to judge from appearances only, we might imagine, that so far from being useful to the earth, the cold humidity of snow would be detrimental to vegetation. But the experience of all ages asserts the contrary. Snow, particularly in those northern regions where the ground is covered with it for several months, fructifies the earth, by guarding the corn or other vegetables from the intenser cold of the air, and especially from the cold piercing winds. It has been a vulgar opinion, very generally received, that snow fertilizes the land on which it falls more than rain, in consequence of the nitrous salts which it is supposed to acquire by freezing. But it appears from the experiments of Margraaf, in the year 1731, that the chemical difference between rain and snow water is exceedingly small; that the latter is somewhat less nitrous, and contains a somewhat less proportion of earth than the former; but neither of them contains either earth, or any kind of salt, in any quantity which can be sensibly efficacious in promoting vegetation. Allowing, therefore, that nitre is a fertilizer of land, which many are upon good grounds disposed utterly to deny, yet so very small is the quantity of it contained in snow, that it cannot be supposed to promote the vegetation of plants upon which the snow has fallen. The peculiar agency of snow as a fertilizer in preference to rain, may admit of a very rational explanation, without recurring to nitrous salts supposed to be contained in it. It may be ascribed to its furnishing a covering to the roots of vegetables, by which they are guarded from the influence of the atmospherical cold, and the internal heat of the earth is prevented from escaping. The internal parts of the earth are heated uniformly to the forty-eighth degree of Fahrenheit's thermometer. This degree of heat is greater than that in which the watery juices of vegetables freeze, and it is propagated from the inward parts of the earth to the surface on which the vegetables grow. The atmosphere being variably heated by the action of the sun in different climates, and in the same climate at different seasons, communicates to the surface of the earth, and to some distance below it, the degree of heat or cold which prevails in itself. Different vegetables are able to preserve life under different degrees of cold, but all of them perish when the cold which reaches their roots is extreme. Providence has, therefore, in the coldest climates, provided a covering of snow for the roots of vegetables, by which they are protected from the influence of the atmospherical cold. The snow keeps in the internal heat of the earth, which surrounds the roots of vegetables, and defends them from the cold of the atmosphere.

Snow *grotto*, an excavation made by the waters on the side of Mount Etna, by making their way under the layers of lava, and by carrying away the bed of puzzolana below them. It occurred to the proprietor, that this place was very suitable for a magazine of snow; for in Sicily, at Naples, and particularly at Malta, they are obliged, for want of ice, to make use of snow for cooling their wine, sherbet, and other liquors, and for making sweatmeats. This grotto was hired or bought by the Knights of Malta, who, having neither ice nor snow on the burning rock which they inhabit, have hired several caverns on Etna, in which people, whom they employ, collect and preserve quantities of snow, to be sent to Malta when needed. This grotto has therefore been repaired within at the expense of that order: flights of steps are cut into it, as well as two openings from above, by which they throw in the snow, and through which the grotto is enlightened. Above the grotto they have also levelled a piece of ground of considerable extent; this they have inclosed with thick and lofty walls, so that when the winds, which at this elevation blow with great violence, carry the snow from the higher parts of the mountain, and deposit it in this inclosure, it is retained and amassed by the walls. The people then remove it into the grotto through the two openings, and it is there laid up, and preserved in such a manner as to resist the force of the summer heats; as the layers of lava, with which the grotto is arched above, prevent them from making any impression.

When the season for exporting the snow comes on, it is put into large bags, in which it is pressed as closely as possible; it is then carried by men out of the grotto and laid upon mules, which convey it to the shore, where small vessels are waiting to carry it away. But

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before those lumps of snow are put into bags, they are wrapped in fresh leaves; so that while they are conveyed from the grotto to the shore, the leaves may prevent the rays of the sun from making any impression upon them. The Sicilians carry on a considerable trade in snow, which affords employment to some thousands of mules, horses, and men. They have magazines of it on the summits of their loftiest mountains, from which they distribute it through all their cities, towns, and houses; for every person in the island makes use of snow. They consider the practice of cooling their liquors as absolutely necessary for the preservation of health; and in a climate, the heat of which is constantly relaxing the fibres, cooling liquors, by communicating a proper tone to the fibres of the stomach, must greatly strengthen them for the performance of their functions.

Snow, in naval affairs, a vessel equipped with two masts, resembling the main and fore-masts of a ship, and a third small mast just abaft the main-mast, carrying a sail nearly similar to a ship's mizen; the foot of this mast is fixed in a block of wood, upon deck, and the lead is attached to the after part of the main top. The sail is called a try-sail, and hence the mast is termed a try-sail-mast. When sloops of war are rigged as snows, they are furnished with a strong rope, called a horse, instead of the try-sail-mast, the fore part of the sail being attached by rings to it. This is generally the largest of all two-masted vessels employed by Europeans, and is reckoned the most convenient for navigation. See Falconer's Marine Dictionary.

SNUFF, a powder chiefly made of tobacco, the use of which is too well known to need any description here. However, though tobacco be the basis of snuff, yet a multiplicity of other matters are often added, to give it an agreeable scent. The kinds of snuff being endless, we shall only observe, that there are three grand sorts, *viz.* that which is only granulated, and called rappee; that which is reduced to a very fine powder, and called Scotch, Spanish, &c. snuff; and the third, a coarse kind, remaining after sifting the second sort.

SOAP, a composition of caustic fixed alkaline salt and oil, or other grease. It is sometimes hard and dry, sometimes soft and liquid; much used in washing, and other purposes, as well in the arts and manufactures as in domestic purposes. The manufacture of soap in and near London first began in the year 1524: before this our countrymen imported the best soap from foreign parts, though they were supplied with an inferior sort from Bristol.

The materials used in soap-making are, oil of any kind, vegetable or animal; and fixed alkali, either soda or potash. These (that is, oil and alkali) enter into the composition of every soap, and, besides, lime is essential to give the alkali the requisite degree of causticity: common salt is also employed in most of the potash soaps.

The general process of soap-making is on the whole very simple; and consists, first, in making a caustic, or partly caustic, ley, with the alkali and lime; next, of boiling the ley with the oil till they are perfectly united into a smooth uniform soap; and lastly, of drying the soap till it is become of a proper consistence for use. But though the general process is simple, and success to a certain degree may be insured by any one who puts the proper ingredients together in the plainest manner, there are a considerable number of precautions, and many minute attentions, required, to make the best and most perfect article with the greatest economy. The simplest, and on the whole the most beautiful soap, is the fine white soap prepared from olive oil and soda, extracted from the best barilla, which is manufactured very largely in the countries where the olive grows, especially in the south of France, in some parts of Italy, and in Tripoli.

Soap is manufactured in this country principally from tallow, or any other fat; and the alkali employed is either barilla or pearl-ash, or a mixture of the two, according to the price and practice of the manufacturer. But as potash alone will not make a stiff soap, recourse is had to the action of common salt, which, when added after the potash and oil are united, produces a separation of the compound from the water incorporated with it, hardens it, and renders it equal to the soda soaps. The following is the usual method of making the common white and yellow soap used in domestic purposes. White hard soap is generally made with three separate charges of ley. The potash (supposing this to be the alkali) is previously dissolved with water in a small boiler, with a little fire, and the solution is poured over a vat, containing common wood ashes mixed with lime, which makes the first and strongest ley.

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As soon as this has run off, the ashes are turned, more lime is added, and water is pumped on, which forms the second, or weak ley. The large boiler is then charged with the tallow, and about two-thirds of the strong ley being added, a moderate fire is kept up, to incorporate the materials, which is known by their running into a stiff glue. If this does not take place in about seven hours (with 29 *cwt.* of tallow in the boiler) more alkali must be added. The tallow is then killed, or saturated, and the fire is drawn, and the materials allowed to remain at rest for a short time. Common salt is then thrown in, and stirred up with long poles till it is thoroughly incorporated, and till the mater changes from a dark coloured glue to a thin soapy substance. A brisk fire is then made, and the materials boiled for a few minutes, when the fire is again drawn, and the materials in the boiler allowed to settle for an hour and a half, during which the spent lees sink to the bottom of the boiler, and are pumped off. The second operation begins with raising the fire, and adding to the soapy mass the weak ley, which is to be managed the same as at first, and again brings it to the state of a glue, which a very little salt will restore to the saponaceous state, and after boiling and cooling the second lees are pumped off. In the third operation, the third part of the strong ley which was reserved is added, which, as before, changes the mass to a thick glue, that must be grained with salt as before. The contents are then boiled strongly for three hours, more or less, till, by taking samples occasionally with a trowel, the soap feels sufficiently hard and dry to the touch, and the ley will be seen to run quite clear from the soap on the trowel, leaving this latter in round lumps. The boil of soap is then finished, by pumping off the spent ley, and scraping off a quantity of light froth from the top of the soap, and the soap is fit for framing.

Soap is soluble in alcohol. The solution of soap is decomposed by all the acids, which curdle it, or separate the oil in the form of white lumps. An excess of acid re-dissolves the curd, and the oil is transferred to the acid; but on boiling this solution, the oil separates entirely, and rises to the surface. The solution is also curdled by lime, barytic, or strontian water, and in this case the curd consists of the oil united with the earth, and concreted by this union. All the soluble salts of these and the other earthy bases equally decompose soap water, and form a curdy precipitate, which is the reason why hard water, that always contains sulphate of lime, and often other earthy salts, immediately curdles soap, instead of forming an uniform solution. The metallic salts will produce the same effect, and a combination of the oil and metallic oxide is produced. See Aikin's Dict.

SOCAGE, a tenure of lands by or for certain inferior services of husbandry to be performed to the lord of the fee. This was a tenure of so large an extent, that all the lands in England, which were not held in knight-service, were held in socage. Since the time of Charles II. all the lands in England are reduced to socage tenures.

SOCIETIES. This word includes a vast circle of associations of men, calculated in some instances to promote the cause of science and literature, and in others intended for the benefit of the individuals, and their families, who compose them.

Of the former class are the Royal and Antiquarian Societies, and the more recent establishments, under the term of INSTITUTIONS.

SOCIETY, *Royal*, had its origin from the voluntary intercourse of learned men, who conceived that their pursuits might be improved and forwarded by the communication of their thoughts and observations to each other during their leisure hours. Dr. Wilkins, of Wadham College, Oxford, who entertained the resident philosophers of that university at his lodgings weekly, for this feast of reason, deserves the honour of founding the Society, as it was there the more expanded idea of future benefit to the community was generated and matured, and which would probably have been carried into effect, had not the unhappy civil war, during the reign of Charles I. banished every laudable public intention from the minds of the learned, and converted the seat of learning into a military post.

Thus expelled from Oxford, we find that many of the members of this infant society afterwards resided in London, and still cherishing the plan, they contrived to meet at Gresham College between the years 1658 and 1663. The evident advantages likely to be derived from the labours of the philosopher, who was by this means compelled to exert his best faculties to escape free from the scrutinizing observations of his brethren in science, to whom they were submitted, soon attracted the

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notice of those who had sufficient influence at court to procure a charter of incorporation from a monarch, whose pursuits were widely different, and which was dated April 22, 1663. This act, reflecting equal honour on the age and nation, was accompanied by a declaration from the King, expressed within it, that he wished to be considered in the threefold character of founder, patron, and companion.

Thus the Society received the royal protection, and became a body politic, under the direction of a president and council, who were elected by the fellows or members; the latter also cannot obtain admission without the routine of being proposed by persons already admitted, who, by this means, become responsible for the propriety of the recommendation; and a formal ballot, which takes place after a sufficient time has elapsed to enable the Society to judge whether the candidate has just pretensions to the honourable and learned distinction of Fellow of the Royal Society, "for promoting the knowledge of natural things and useful experiments." The liberality, which, almost universally, distinguishes the genuine philosopher, soon furnished their apartments with valuable and interesting natural and artificial productions; and they were sufficiently numerous at the commencement of the eighteenth century to compose a folio catalogue, for which the public are indebted to Dr. Grew: since that period the contributions have greatly multiplied, and form a most important collection. The meetings are now held weekly, for the general purposes of the Society, from the middle of November till July, on Thursday evenings, between the hours of eight and nine o'clock, when those papers are read which the secretary receives in the interval between each meeting, and exhibits such curiosities as may be sent to him for that purpose. Their own declaration, made very long since, will contribute to explain the nature of the communications to this valuable institution, which is calculated to "make faithful records of all the works of nature or art which come within their reach; so that the present, as well as after ages, may be enabled to put a mark on errors which have been strengthened by long prescription; to restore truths that have been neglected; to put those already known to more various uses, and to make the way more passable to what remains unrevealed."

Society *of Antiquarians*. Though the object of this body is of rather less importance than that of the Royal Society, yet it has obtained a celebrity little inferior, as much has been done by it towards ascertaining the changes which have taken place in the surface of the earth, exclusive of the principal purpose of the association, which is to generate a liking for the study of our national antiquities; so that, in the sequel, genuine history shall be preferred to the superficial information gleaned from monastic writers; this will be still further explained by the preamble of the charter, which asserts, that the study of antiquity, and the history of former times, has ever been esteemed highly commendable and useful, not only to improve the minds of men, but also to incite them to virtuous and noble actions, and such as may hereafter render them famous and worthy examples to late posterity.

When we recollect, that from the time of Henry VIII. learning began to be more generally diffused throughout all ranks of people, and that Leland, Stowe, Camden, Dugdale, Speed, Sir Robert Cotton, and many other eminent antiquarians, used every endeavour to rouse their countrymen into a relish for their pursuits, it may be readily supposed that attempts were made to form a society, which might more effectually promote individual views; that such attempts occurred we have sufficient evidence, but that some adverse cause existed to prevent their fruition equal proof exists, in the fact, that the society did not receive the royal sanction till 1751, when George II. granted the infant association a charter of incorporation, dated November 2, in the above year: this instrument declared the monarch to be the founder and patron of the society, which is enabled to receive and hold in perpetuity any antiquities, books, manuscripts, &c. and lands, tenements, and hereditaments, not exceeding the yearly value of one thousand pounds, which the generosity of individuals may prompt them to bestow on the members collectively; or the society may purchase property of the same description, to the same amount, without license of alienation in mortmain.

The government of the society consists of twenty-one persons, of whom one is constituted a president; and the first so honoured was the celebrated Martin Folkes, Esq. who held that office till the 23d of April, the day appointed for all subsequent elections, which the charter declares shall be annual. The first council under the act of incorporation contained the names of Viscount Fitzwilliam, Lord Willoughby of Parham, James West,

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Esq. Mr. Gale, Mr. Wray, Dr. Browne Willis, Dr. Rawlinson, and Arries, and Vertue, names that reflected honour on the nation, and were well calculated to confirm the credit and stability of the society, which the King ordained should be composed of men of acknowledged abilities judging from the following excellent criterion of their pretensions; "by how much any person shall be more excelling in the knowledge of the antiquities and history of this and other nations; by how much the more they are desirous to promote the honour, business, and emoluments of this society; and by how much the more eminent they shall be for piety, virtue, integrity, and loyalty; by so much the more fit and worthy shall such person be judged of being elected and admitted into the said society."

Their transactions, as a body, are under the control of an elective director, who superintends the progress of intended works, of which the society have published fifteen quarto volumes, under the title Archæologia, illustrated with engravings, three of Vetusta Monumenta, and a very considerable number of separate prints, and particularly of elevations of cathedrals.

The general meetings of the society are held on every Thursday evening, between the months of November and July, and immediately before the sitting of the Royal Society, whose apartments are separated by an anti-room, common to both, from those belonging to the Antiquarians in Somerset House; in the left wing of which the latter have an excellent library, open to the fellows from ten till four o'clock every day, who have the further privilege of borrowing books for any time not exceeding a month, by a written application at a general meeting, or to the secretary during the recess.

Similar to the proceedings of the Royal Society, all communications must be made to the secretary, who reads those thought to possess sufficient merit, and in the same manner exhibits fragments of antiquity and drawings, all which are heard and examined in profound silence.

Society *for the encouragement of Arts, Manufactures, and Commerce.* This institution originated from the truly patriotic views of several worthy members of the community, who were sensible that rewards from a society formed of the noble, the rich, and the learned, were better calculated to produce emulation in every department of the pursuits mentioned in the title of it, than the mere prospect of advantage to be derived from the employment of individuals. The idea seems to have met the approbation of the public, and a very short time elapsed, ere sufficient sums of money were procured to set this useful and respectable body in motion: we now find them fixed in a superb mansion, part of the Adelphi Buildings, splendidly adorned with paintings presented by the late Mr. Barry, the work of his own pencil, and surrounded by numerous models of articles, which render their inventors memorable, and their patrons more honourable members of society than the most adventurous military heroes of ancient or modern times.

Subscriptions for life, and by the year, and some other resources, supply the wants of the institution, which are confined to the actual expenses of their hall, their officers and servants, and the rewards honorary and pecuniary. In explaining their motives, they say their object is to promote the arts, manufactures, and commerce of this kingdom, by giving rewards for all such useful inventions, discoveries, or improvements as tend to that purpose; and in pursuance of this plan, the society has already expended between forty and fifty thousand pounds, advanced by the voluntary subscription of their members, and legacies bequeathed. The manner in which the above vast sum has been distributed is most honourably explained, by the secretary and other officers, at the hall; and the register, exhibited at the same time, will show the very great advantages which the public derives from the institution. The meetings of the society are held every Wednesday, at seven o'clock in the evening, from October to June, and the various committees on other evenings during the session. Each member has the privilege, on any weekly meeting, of proposing a candidate for admission, provided three members sign the written instrument prescribed for that purpose. Peers of the realm, or lords of parliament, are ballotted for immediately upon being proposed; but the names of all others must be inserted in a list which the secretary suspends in the meeting room; the person is then ballotted for, and if two-thirds of the members present vote in his favour, he becomes a perpetual member on paying twenty guineas, or a subscribing member upon payment of any sum amounting to not less than two guineas per annum. Every member is admitted to participate in all the transactions of the society, and may attend and vote at the several committees; besides

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which, he has the privilege, at the weekly meetings, of proposing two persons as auditors of the general accounts, and, by addressing a note to the registrar, of introducing his friend to examine the numerous models, machines, and productions, in different branches of arts, manufactures and commerce, for which rewards have been bestowed; and to inspect the magnificent series of moral and historical paintings, so happily contrived and completed by James Barry, Esq. which with some valuable busts and statues, decorate the great room. He has also the use of a valuable library, and is entitled to the annual volume of the Society's Transactions.

Our limits will not permit us to give more than the heads of the subjects for which premiums are offered, as the ramifications of each are very numerous, in order to render the operations of the society as useful as possible. They are, for planting and husbandry, containing fifty-seven classes; for discoveries and improvements in chemistry, dyeing, and mineralogy, in twenty-eight classes: for promoting the polite arts, including one class offered by the will of John Stock, Esq. for sculpture, twenty-two classes; for encouraging and improving manufactures, six classes; for inventions in mechanics, twelve classes; and to these are added premiums for the advantage of the British colonies and the British settlements in the East Indies, in thirty-four classes. The premiums alluded to are medals of gold and silver, gold and silver pallets, and purses of ten, and twenty, or thirty, &c. guineas.

As the primary object of the society, in offering these rewards, is to rouse the energy of individuals, and to give currency to their inventions and improvements which appear to promise general benefit, the society is careful to acquaint the candidates for them, "that if the means, by which the respective objects are effected, do require an expense or trouble too great for general purposes, the society will not consider itself as bound to give the offered reward; but though it thus reserves the power of giving, in all cases, such part only of any premium as the performance shall be adjudged to deserve, or of withholding the whole, if there be no merit; yet the candidates may be assured, the society will always judge liberally of their several claims." The society requires that the subjects, offered for obtaining the premiums, should be delivered at their house, without the names of the inventors or improvers, or any intimation by which they may be discovered; and that each subject thus offered shall have some private mark affixed, which mark must appear upon the outside of a sealed paper, containing within, the claimant's name and address, to be delivered with the model, machine, &c. and they very properly refuse to perform their part of this liberal compact, unless the candidate literally complies with these judicious and necessary rules to preserve the strictest impartiality.

The society opens no papers, except that corresponding to the mark which obtains a premium, unless it should in some case become necessary for the determination of the claim; the remainder of the papers are returned, with the articles they belong to, if inquired after by the mark within two years; should they not be demanded at the close of that period, they are publicly burnt, in the state in which they were sent, during the sitting of the society. The models that are considered worthy of a premium, or bounty, become the property of the Society, and when either is granted for a machine, the party receiving it is expected to present the Institution with a perfect model. As it cannot be expected that the funds of the society should amount to a sum equal to the claims of very numerous applicants, its bounties are necessarily confined to the residents of Great Britain and Ireland, except an express intimation to the contrary occurs; nor can any person receive a premium, who has obtained a patent for his discovery or improvement; besides, every person claiming is expected to act in the same open and ingenuous manner adopted by the society; for should he be detected in any unfair attempts to secure success, he not only forfeits all pretensions for the time, but is rendered incapable of future application.

The performances sent each year, which have obtained rewards, are left in the possession of the institution till after the public distribution of them, but no member can be a candidate for any thing more than the honorary medal of the society. "The candidates are, in all cases, expected to furnish a particular account of the subject of their claims: and where certificates are required to be produced in claim of premiums, they are to be expressed as clearly as possible in the words of the respective advertisements, and to be signed by persons who

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have a positive knowledge of the facts stated. Where premiums or bounties are obtained, in consequence of specimens produced, the society retains such part of those specimens as it judges necessary, at the same time making reasonable compensation to the party concerned, who cannot be admitted to any of the meetings of the society, or its committees, or at their rooms, after they have delivered their claims, unless they are summoned by the latter. The stated periods for distributing the rewards produce a most interesting series of spectacles, which are not perhaps equalled by the operations of any other society.

Were we to follow the subject of this article to the extent it deserves, we should enter into an account of the

Society *for the relief of persons confined for small debts*, which originated in the benevolent mind of Dr. Dodd, and has been continued to the present moment with great success: and of the

Society, *Royal Humane, for the recovery of persons from supposed death*, and of various others, under different denominations, exclusive of the

Societies, *benefit*, which have recently, under the authority of an act of parliament, been established throughout the kingdom; and which deserve every possible encouragement, as by their operation the poorest labourer may, by the weekly deposit of a very small portion of his earnings, assist in forming a fund, that will, in the event of illness, afford him every comfort, and a decent funeral, should it prove fatal.

Several most respectable and laudable societies have lately been founded, as the London Institution, the Surry Institution, the Russell Institution, and the Royal Institution; of the Royal and London Institutions we shall proceed to give some account.

Royal Institution. The immediate origin of this important society will be best explained by the following short extract from a letter written by Count Rumford, in 1799, to the committee of the society, for "bettering the condition of the poor." "Inclosed I have the honour to send you a corrected copy of the proposals I took the liberty of laying before you on Thursday last, for forming in this capital, by private subscription, a public institution for diffusing the knowledge, and facilitating the general and speedy introduction of new and useful mechanical inventions and improvements; and also for teaching, by regular courses of philosophical lectures and experiments, the application of the new discoveries in science to the improvement of arts and manufactures, and in facilitating the means of procuring the comforts and conveniences of life."

The committee made use of the first opportunity of communicating the above proposal to the society of which they were the acting members; the society immediately appointed a new committee to confer with the Count, and they reported, "that they were satisfied that the institution proposed by him would be extremely beneficial and interesting to the community;" and they recommended that, in order to procure the necessary sum of money for establishing it, subscribers of fifty guineas each should become perpetual proprietors of the new institution; and that each of those persons should have perpetual transferable tickets for the lectures, besides admission to the apartments; further proposing, that when thirty such subscribers were obtained they should be invited to meet, to receive the plan, and elect managers for the future proceedings. This report was favourably received and adopted, and a paper was immediately printed, explaining the proposed institution, and inviting those to whom it was communicated to become subscribers on the above terms; fifty-eight names were instantly procured, of the highest respectability; the usual measures were pursued, in order to give permanency and consequence to the undertaking; they were completely successful, and we now find it flourishing under the royal sanction, an honour to the nation and inventor, to whom we should be highly ungrateful, did we omit to give an outline of his original plan, which must of course be the basis of all present and future operations.

Spacious and airy rooms he considered absolutely necessary for the reception and exhibition of mechanical inventions and improvements, and those are to be confined to such as tend to increase the conveniences and comforts of life, to establish domestic economy, improve taste, and useful industry; and in order to promote this part of the views of the institution to the utmost, he proposed that the best models should be procured and shown in action, or actual use, of cottage fire-places, and kitchen utensils for cottagers, a complete kitchen for a farm-house, with all the necessary utensils; a complete kitchen, with the utensils, for the family of a man of fortune; a complete

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laundry for a gentleman's family; and a public hospital, including all the usual apparatus; Russian, Swedish, and German stoves; open fire-places, on the best principles, with fires in them; ornamental and economical grates; stoves in elegant forms, for halls, drawing and eating rooms, &c. He next proposed to exhibit working models of the steam-engine, on a reduced scale, and of all the varieties of boilers for manufactories, hospitals, and ships, with improved fire-places; models of ventilators for rooms and ships; models of hot-houses, of lime-kilns, of boilers, steam-boilers, &c. for preparing food for cattle stall-fed; of cottages, spinning-wheels, and looms, calculated for the advantage of the poor, or any other machinery to employ them at home; models of all newly invented machines and implements, likely to become beneficial in husbandry; models of variously constructed bridges, and any others which the managers may hereafter deem worthy of a place in so extensive a collection: that this part of the establishment may be rendered as useful as possible, the Count proposed that illustrative drawings should accompany the models, &c. with a written description, and the prices affixed at which the articles may be procured.

The second object of the institution is, the teaching the application of science to the useful purposes of life: for this branch a lecture room was to be provided, which might serve at the same time for philosophical experiments, with a complete laboratory and philosophical apparatus; the room he wished to contain convenient places for the subscribers, which he recommends should be well warmed and perfectly ventilated; the lecturers to be chosen by the managers, with the utmost circumspection; that none but men of eminence, in their respective pursuits, should officiate in that most important and most distinguished situation; and, he adds, "no subjects will ever be permitted to be discussed at these lectures but such as are strictly scientifical, and immediately connected with that particular branch of science publicly announced as the subject of the lecture." Persons, by his plan, are to be permitted to attend the lectures on being recommended by a subscriber, and paying a small sum. The subject of the lectures he proposed should be, on the application of heat to the various purposes of life; the combustion of inflammable bodies, and the relative quantities of heat producible by the different substances used as fuel; the management of fire, and the economy of fuel; the principles of the warmth of clothing; the effects of heat and cold, and of winds of each description, on the human body, in health and illness; the effects of vitiated air; the means of rendering dwelling-houses healthy and comfortable; the procuring and preserving of ice, and construction of ice-houses; preserving food in different seasons and climates; cooling fluids without the assistance of ice; on vegetation, and of the specific nature of those that are produced by manures; of composing the latter, and adapting it to particular soils; the nature of those changes that are produced on substances used as food, and of that which takes place in its digestion; the chemical principles of tanning hides, and their improvement; the chemical principles of the art of making soap; of the art of bleaching, dyeing, and, in general, of all the mechanical arts, as they apply to the various branches of manufacture.

At the first meeting of the managers, held at the house of Sir Joseph Banks, March 9, 1799, when that gentleman presided, it was proposed and resolved, "that the proposals for forming the institution, as published by Count Rumford, be approved and adopted by the managers; subject, however, to such partial modifications, as shall be by them found to be necessary or useful."

A Committee of Managers, chosen by ballot from the proprietors, direct and govern all the concerns of the institution; the three first of whom serve three years, the second two years, and the third one year; the whole nine being eligible for re-election; as no emolument whatever accrues to the managers, they are considered as having pledged their honour to preserve the establishment inviolate; they are required to insure the effects under their care from fire; to keep an exact account of all the property, of the receipts and expenditure, and minutes of all their proceedings; besides preserving the utmost order, and exercising the strictest economy in all their pecuniary acts; and they are forbidden to give premiums, or rewards, to those who invent any things useful, the design of the institution being exclusively for improvement and diffusion of knowledge.

A Committee of Visitors, selected from the proprietors, totally distinct from the managers, are appointed to inspect the proceedings of the latter. Such is the

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Royal Institution; from which we shall now turn our attention to the

London Institution, *for the advancement of Literature and the diffusion of useful Knowledge.* The original object of the promoters of this undertaking was, the acquisition of an extensive and valuable library, to diffuse useful knowledge by the means of lectures and experiments, and to establish a reading-room, for the reception and use of foreign and domestic journals, periodical works, pamphlets, and new publications. Having accomplished this, procured a charter, and fairly set the machine in motion, the following regulations were adopted: all the concerns of the institution are governed by a committee of Managers, composed of the President, four Vice Presidents, twenty Managers, and the Secretary, who are chosen by and from the proprietors, one fourth of whom vacate their offices annually, but may be re-elected. A Committee of Visitors, consisting of the President and twelve other persons, none of whom are managers, elected by the proprietors from their own body, one fourth vacating their offices, as in the case of the managers, have authority to examine, at any time, every department of the institution, making their report at their own option, either to the Committee of Managers, or Court of Proprietors; and five of these concurring in the propriety of the measure, may convene a special general meeting of the proprietors, after giving eight days previous notice.

An annual meeting is held in April, when five auditors are appointed by and from the proprietors, who are to examine the accounts of the institution, and prepare a report, to be printed, and presented to each proprietor previous to the next annual meeting; and at this meeting the election of the president, one vice-president, five managers, three visitors, the treasurer and secretary, takes place. The president or a vice-president takes the chair; but if neither should happen to be present, a manager is to preside: the secretary makes minutes of the proceedings, which are read at the next meeting, and if then approved of as correct, are to be signed by the president or chairman: notice is given eight days before the meeting in four of the morning papers, and papers for the intended ballot are prepared at the house of the institution: many other regulations are established on this head, and for calling special meetings, which are highly useful and proper, but are too long for this article. The managers are empowered to engage professors and lecturers, who are to enter into courses on experimental philosophy, chemistry, and on the different departments of literature and the arts, which are to be given annually, or more frequently, if thought proper, at the rooms of the establishment, at which time the managers are required to be careful that no other subjects are treated of, except such are decidedly connected with the objects of it. The managers are besides to elect and appoint annually, or otherwise, the professors, lecturers, librarians, the assistant secretaries, and other officers, who are subject to their control, and may be dismissed by them; and they have the same powers with all the domestic servants of the institution; they also direct all the affairs of the house, and make such regulations for it as they may think proper; appoint a superintendant of the inferior officers, and their expenses; and may permit such attendants as they please to reside in the house. The managers are required to keep registers of all their receipts and payments, their own transactions, and those of their agents, &c. which, with the necessary vouchers, are to be completed to the 31st of December annually, and laid before the auditors by the 25th of March following. They have additional powers to admit foreigners of high rank, or of distinguished scientific acquirements, to the lectures, library, and other rooms of the establishment. Their meetings must be held in the house, nor can any business be transacted by them, unless three members at least are present. Those meetings are monthly; and special meetings may be called, on the requisition of the president, or two vice-presidents, or any three managers; the president, a vice-president, or a manager, may preside on each of these occasions; and the president, or chairman, is allowed a double vote, when an equal division takes place on a question.

The visitors cannot act unless three are assembled; and they meet in March, June, September, and December; but other special meetings of them may be convened: they are to elect from their own body a secretary, who is to make minutes of their proceedings, but his office is entirely honorary.

The number of proprietors is limited at present to 1000: after the charter was obtained, the sum to be demanded of such is 100 guineas; and the method observed in supplying the vacancies hitherto has been, by vesting that power in the temporary committee of managers, who

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deliberately add to the list persons whose merit and abilities are likely to prove advantageous to the institution; their qualification, however, is but seventy-five guineas. A candidate for this honour must be proposed by a manager at the monthly meeting of that body; the name is suspended in the room for one month, when a ballot takes place, and a majority of two-thirds is required in favour of the admission: after he has thus become a proprietor, he is entitled to his certificate, the printed catalogue, other papers of the institution, and tickets of admission, free of any further expense.

The property of the institution is exclusively vested in the proprietors, who, in their collective state, are enabled to dispose of it; consequently no sale, mortgage, or any kind or manner of involving its interests, can possibly occur, unless by consent of the whole. In return for this, they, and the subscribers and honorary members, have the common right of admission to the lectures, library, and reading rooms, &c. &c. every day, and at all hours, from eight o'clock in the morning till eleven at night, with the usual exceptions of Sundays, holidays, and Saturdays, when the doors are closed at three o'clock in the afternoon; the proprietors have, besides, one transferable ticket each, which admits to the places already enumerated. A proprietor, who may be desirous of transferring his right in the institution, must inform the committee of managers of the name and residence of the intended purchaser in writing, who is ballotted for at their next meeting, unless the transfer should be to the possessor's son, who is admitted without that ceremony; if the person should be rejected, another may be proposed; and if he also should be disapproved of, the proprietor wishing to sell may claim from the funds of the institution such sum as may then be fixed in the bye-laws as the qualification of a proprietor. Upon the decease of a proprietor, his executors may proceed, with some little variation, in the same manner prescribed for the sale of a proprietorship.

Persons of rank and superior qualifications, both natives and foreigners, may be elected honorary members; but two negatives will exclude them upon the ballot. The rights of life and annual subscribers necessarily extend no further than to the use of the rooms and library, nor can they be admitted such without the ceremony of proposing and electing. Subscribers to the library, or to particular courses of lectures, are admitted upon terms fixed by the managers, who also admit ladies in the same way, but to the lectures only.

A meeting of the proprietors was held in October, 1805, when it was resolved, that the sum of 40,000*l.* should as speedily as possible be invested in the funds, in order that a permanent basis might be founded to secure the success of the institution; other sums were at the same time directed to be placed in floating public securities, to be disposed of when the produce should be wanted. The rents, revenues, and annual income, to be applied for rent, taxes, salaries, repairs, &c. &c. and in purchasing foreign and domestic journals, periodical and other new works, for the use of the reading room: the surplus beyond these purposes was directed by the meeting to be used for augmenting the library and the philosophical apparatus.

We shall conclude our account of this excellent institution in the words of the rules for the use of the library. "No person shall take down any of the books in the library; but a note or card, containing the name of the person applying, and the title of the book, must be given to the librarian or attendant, who shall supply him with the book required. No person shall take away any book belonging to the library." A manuscript catalogue is kept for the subscribers in the room; but a printed one is hereafter to be prepared and delivered. "No librarian, or attendant, or any other officer or servant of the institution, shall receive any fee, perquisite, or gratuity, on account of, or during the execution of their office, under penalty of immediate dismission from the service of the institution."

SOCMEN, or SOKEMEN, such tenants as held their lands and tenements in socage; but the tenants in ancient demesne seem most properly to be called socmans.

SOCRATIC *philosophy*, the doctrines and opinions, with regard to morality and religion, maintained and taught by Socrates. By the character of Socrates, left us by the ancients, particularly by his scholars Plato, Laertius, &c. he appears to have been one of the best and the wisest persons in all the heathen world. To him is ascribed the first introduction of moral philosophy, which is what is meant by that usual saying, "that Socrates first called philosophy down from heaven to earth;" that is, from the contemplation of the heavens and

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heavenly bodies, he led men to consider themselves, their own passions, opinions, faculties, duties, actions, &c. He wrote nothing himself, yet all the Grecian sects of philosophers refer their origin to his discipline, particularly the Platonists, Peripatetics, Academics, Cyrenaics, Stoics, &c. but the greatest part of his philosophy we have in the works of Plato.

SODA, in mineralogy and chemistry, is a species of fossil salts, divided by mineralogists into common and radiated natron. Common natron is of a yellowish grey colour: it occurs in fine flakes, or in dusty particles; it has a sharp alkaline taste; effervesces with nitric acid; is easily soluble in water, and its solution changes blue vegetable tinctures to a green; it is fusible before the blow-pipe. It is found either as an efflorescence on the surface of the soil; or on decomposing certain rocks; or on the sides and bottoms of lakes, that become dry by the heat and drought of summer. It is obtained in great abundance in many parts of Germany, and also in Egypt. That from Egypt has, according to Klaproth, yielded to analysis the following substances:

Carbonate of soda	32.6
Sulphate of soda	20.8
Muriate of soda	15.0
Water	31.6
	100.0

The radiated natron is of a yellowish grey colour: it occurs in crusts, and in capillary or acicular crystals, which are aggregated on one another; it is glistening and translucent. This is found native about two days journey from Fezzan, at the bottom of a rocky mountain, forming crusts, usually the thickness of a knife, and sometimes even an inch thick, on the surface of the earth. It is always crystalline. Besides the great quantity carried to Egypt and other parts, there are said to be fifty tons annually sent to Tripoli. It is not adulterated with salt. Though there is abundance of salt in this part of Africa, it must be observed, that the salt mines are situated on the sea coast; whereas the radiated natron, called trona, occurs at the distance of twenty-eight days journey up the country. It is principally employed in the manufacture of glass and soap, and also for the washing of linen. This species has been analyzed by Klaproth, and found to consist of

Sulphate of soda	2.5
Pure soda	37.0
Carbonic acid	31.0
Water of crystallization	22.5
	100.0

Soda was long regarded as a simple body; it has, however, at length been decomposed by Mr. Davy. See the article Potash, where a brief account is given of the discovery.

SOFFITA, or Soffit, in architecture, any plafond, or ceiling, formed of cross beams of flying cornishes, the square compartments or pannels of which are enriched with sculpture, painting, or gilding.

SOHO, the name of a set of works, or manufactory of a variety of hard wares, belonging to Mr. Boulton, situated on the borders of Staffordshire, within two miles of Birmingham, now so justly celebrated as to claim a short notice in this place. About thirty or forty years ago, the premises consisted of a small mill and a few obscure dwellings. Mr. Bolton in conjunction with Mr. Fothergill, then his partner, at an expense of nine thousand pounds, erected a handsome and extensive edifice, with a view of manufacturing metallic toys. The first productions consisted of buttons, buckles, watch-chains, trinkets, and such other articles as were peculiar to Birmingham. Novelty, taste and variety, were, however, always conspicuous: and plated wares, known by the name of Sheffield plate, comprising a great variety of useful and ornamental articles, became another permanent subject of manufacture. To open channels for the consumption of these commodities, all the northern part of Europe was explored by the mercantile partner, Mr. Fothergill. A wide and extensive correspondence was thus established, the undertaking became well known, and the manufacturer, by becoming his own merchant, eventually enjoyed a double profit. Impelled by an ardent attachment to the arts, and by the patriotic ambition of forming his favourite Soho into a fruitful seminary of artists, the proprietor extended his views, and men of taste and talents were now sought for and liberally patronized. A successful

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imitation of the French or moulic ornaments, consisting of vases, tripods, candelabra, &c. &c. extended the celebrity of the works. Services of plate, and other works in silver, both massive and airy, were added, and an assay office was established in Birmingham. Mr. Watt, the ingenious improver of the steam-engine, is now in partnership with Mr. Boulton, and they carry on at Soho a manufactory of steam-engines, not less beneficial to the public than lucrative to themselves. This valuable machine, the nature and excellencies of which are described in another place, (see STEAM-ENGINE,) Mr. Boulton has applied to the operation of coining; and to the rolling of iron from bars into thin sheets; to the purposes of button-making, and a number of other mechanical operations, of the highest utility to the national wealth and prosperity.

SOIT FAIT COMME IL EST DESIRE', *be it done as it is desired*, a form used when the king gives the royal assent to a private bill preferred in parliament.

SOL, or SOU, a French coin made up of copper mixed with a little silver.

SOL, the *sun*, in astronomy, astrology, &c. See SUN.

SOL, in chemistry, is gold; thus called, from an opinion that this metal is in a particular manner under the influence of the sun.

SOL, in heraldry, denotes *Or*, the golden colour in the arms of sovereign princes.

SOLANDRA, in botany, named in honour of Daniel Charles Solander, a Swede, a genus of the Pentandria Monogynia class and order. Essential character: calyx bursting; corolla clavate, funnel-form, very large; berry four-celled, many-seeded. There is but one species, *viz.* S. grandiflora, great flowered Solandra, a native of Jamaica.

SOLANUM, in botany, *nightshade*, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla wheel-shaped; anthers subcoalescent, opening at top by a double pore; berry two-celled. There are ninety-three species, of which the following are the most remarkable. S. dulcamora, woody nightshade, a native of Britain and of Africa, is a slender climbing plant, rising to six or more feet in height. The leaves are generally oval, pointed, and of a deep-green colour; the flowers hang in loose clusters, of a purple colour, and divided into five pointed segments. It grows in hedges well supplied with water, and flowers about the end of June. On chewing the roots, we first feel a bitter, then a sweet taste: hence the name. The berries are said to be poisonous, and may easily be mistaken by children for currants. The younger branches are directed for use, and may be employed either fresh or dried; they should be gathered in the autumn. This plant is generally given in decoction or infusion. Several authors take notice, that the dulcamora partakes of the milder powers of the nightshade, joined to a resolvent and saponaceous quality. S. nigrum, garden nightshade, common in many places in Britain, about dunghills and waste places. It rises to about two feet in height. The stalk herbaceous; the leaves alternate, irregularly oval, indented, and clothed with soft hairs. The flowers are white; the berries black and shining. It appears to possess the deleterious qualities of the other nightshades in a very high degree, and even the smell of the plant is said to cause sleep. The berries are equally poisonous with the leaves, causing cardialgia and delirium, and violent distortions of the limbs in children. In ancient times it was employed externally as a discutient and anodyne in some cutaneous affections, tumefactions of the glands, ulcers, and disorders of the eyes. A variety of the solanum nigrum, a native of the West Indies, is called guma by the negroes. It is so far from having any deleterious quality, that it is daily served up at table as greens or spinach. It has an agreeable bitter taste. S. lycopersicum, the love-apple, or tomato, is cultivated in gardens in the warmer parts of Europe, and in all tropical countries. The stalk is herbaceous: the leaves pinnated, oval, pointed, and deeply divided The flowers are on simple racemi; they are small and yellow. The berry is of the size of a plum: they are smooth, shining, soft; and are either of a yellow or reddish colour.

S. tuberosum, or common potatoe, is a species of this genus, which is too well known to require description.

SOLAR, something belonging to the sun; thus the solar system is that system of the world wherein the heavenly bodies are made to revolve round the sun as the centre of their motion. Also the solar year is that consisting of three hundred and sixty-five days, five hours and forty-nine minutes, in opposition to the lunar-

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year, consisting of three hundred and fifty-four days.

SOLDANELLA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Preciæ. Lysimachiæ, Jussieu. Essential character: corolla bell-shaped, lacero multifid; capsule one-celled, many-toothed at the top. There is only one species, *viz.* S. alpina, Alpine soldanella.

SOLDER, Sodder, or Soder, a metallic or mineral composition used in soldering, or joining together, other metals. See the next article. Solders are made of gold, silver, copper, tin, bismuth, and lead; usually observing, that in the composition there be some of the metal that is to be soldered mixed with some higher and finer metals. Goldsmiths usually make four kinds of solder, *viz.* solder of eight, where to seven parts of silver there is one of brass or copper; solder of six, where only a sixth part is copper; solder of four, and solder of three. It is the mixture of copper in the solder that makes raised plate come always cheaper than flat. The solder used by plumbers is made of two pounds of lead to one of block-tin. Its goodness is tried by melting it and pouring the bigness of a crown-piece upon a table; for if good, there will arise little bright shining stars therein. The solder for copper is made like that of the plumbers, only with copper and tin; for very nice works, instead of tin they sometimes use a quantity of silver. Solder for tin is made of two thirds of tin and one of lead; but where the work is any thing delicate, as in organ pipes, where the juncture is scarce discernible, it is made of one part of bismuth and three parts of pewter.

SOLDERING, among mechanics, the joining and fastening together two pieces of the same metal, or of two different metals, by the fusion and application of some metallic composition on the extremities of the metals to be joined.

SOLE, in natural history. See Pleuronectes.

SOLECISM, in grammar, a false manner of speaking, contrary to the use of language and the rules of grammar, either in respect of declension, conjugation, or syntax.

SOLEN, in natural history, *razor-sheath*, a genus of the Vermes Testacea class and order. Animal an ascidia; shell bivalve, oblong, open at both ends; hinge with a subulate reflected tooth, often double, and not inserted in the opposite valve. There are about twenty-four species, some whereof are straight, others crooked, some red, others variegated with brown and blue, some brown and white, others of a violet-purple colour. This last is a beautiful smooth shell, from three to six inches long, and from one-third to three quarters of an inch in diameter. There is also another not inelegant species, variegated with brown and blue, and a little arcuated. The S. anatinus has the shell ovate, membranaceous, hairy, with a falcate rib at the hinge; the shell is pellucid, white, thin like paper; one end rounded and closed, the other gaping like the beak of a bird; tooth in each valve resembling an ear-picker.

SOLID, in philosophy, a body whose parts are so firmly connected together, as not to give way or slip from each other upon the smallest impression; in which sense solid stands opposed to fluid. Geometricians define a solid to be the third species of magnitude, or that which has three dimensions, *viz.* length, breadth, and thickness or depth. A solid may be conceived to be formed by the revolution, or direct motion, of a superficies of any figure whatever, and is always terminated or contained under one or more planes or surfaces, as a surface is under one or more lines.

Solids are commonly divided into regular and irregular. The regular solids are those terminated by regular and equal planes, and are only five in number, *viz.* the tetrahedron, which consists of four equal triangles; the cube, or hexahedron, of six equal squares; the octahedron, of eight equal triangles; the dodecahedron, of twelve; and the icosihedron, of twenty equal triangles. The irregular solids are almost infinite, comprehending all such as do not come under the definition of regular solids; as the sphere, cylinder, cone, parallelogram, prism, parallelopiped, &c.

Solid *numbers*, are those which arise from the multiplication of a plane number by any other whatsoever; as 18 is a solid number made of 6 (which is plane) multiplied by 3; or of 9 multiplied by 2.

Solid *problem*, in mathematics, is one which cannot be geometrically solved unless by the intersection of a circle and a conic section: or by the intersection of two other conic sections, besides the circle. As to describe an isosceles triangle on a given right line, whose angle at the base shall be triple to that at the vertex. This will help to inscribe a regular hep-

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tagon in a given circle; and may be resolved by the intersection of a parabola and a circle. This problem also helps to inscribe a nonagon in a circle, and may be solved by the intersection of a parabola and an hyperbola between its asymptotes, *viz.* to describe an isosceles triangle, whose angle at the base shall be quadruple of that at the vertex. And such a problem as this hath four solutions, and no more; because two conic sections can cut one another but in four points.

SOLIDAGO, in botany, *golden rod*, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx scales imbricate, closed; corollets of the ray about five; seed down simple; receptacle naked. There are thirty species. The golden rods are natives of North America, excepting two species, which are found in Europe, and two others which were discovered by Houston in New Spain, and have not been adopted by Linnæus, or any other author.

SOLIDITY, that property of matter, or body, by which it excludes all other bodies from the place which itself possesses: and as it would be absurd to suppose that two bodies could possess one and the same place at the same time, it follows, that the softest bodies are equally solid with the hardest. Among geometricians the solidity of a body denotes the quantity or space contained in it, and is called also its solid content.

Solidity, in architecture, is applied both to the consistence of the ground, whereon the foundation of a building is laid, and to a massive in masonry, of extraordinary thickness, without any cavity within.

SOLSTICE, in astronomy, that time when the Sun is in one of the solstitial points; that is, when he is at his greatest distance from the equator, thus called, because he then appears to stand still, and not to change his distance from the equator for some time; an appearance owing to the obliquity of our sphere, and which those living under the equator are strangers to. The solstices are two in each year, the æstival, or summer solstice; and the hyemal or winter solstice. The summer solstice is when the Sun seems to describe the tropic of Cancer, which is on June 22, when he makes the longest day; the winter solstice is when the Sun enters the first degree, or seems to describe the tropic of Capricorn, which is on December 22, when he makes the shortest day. This is to be understood as in our northern hemisphere; for in the southern, the Sun's entrance into Capricorn makes the summer solstice, and that into Cancer the winter solstice. The two points of the ecliptic, wherein the Sun's greatest ascent above the equator, and his descent below it, are terminated, are called the solstitial points; and a circle, supposed to pass through the poles of the world and these points, is called the solstitial colure. The summer solstitial point is in the beginning of the first degree of Cancer, and is called the æstival, or summer point; and the winter solstitial point is in the beginning of the first degree of Capricorn, and is called the winter point. These two points are diametrically opposite to each other.

SOLUM *plantarum*, in botany and gardening, the natural soil of plants, or that which is best adapted to their growth. In the culture, therefore, of plants, it is of importance to have a distinct knowledge of those kinds of soil which are adapted to the several genera and species.

SOLUTION, in chemistry, is the perfect union of a solid substance with a fluid, so as apparently to form one homogeneous liquid. The fluid is termed the solvent, or menstruum. A solution is distinguished from a mixture by being perfectly clear, and from the particles of the solid not separating from the mass when remaining at rest.

SOMMETI, a mineral named from the mountain Somma, where it was first found. It is usually mixed with volcanic productions. It crystallizes in prisms, sometimes terminated by pyramids. Colour white, and somewhat transparent. It cuts glass. The specific gravity is 3.27. Infusible by the blow-pipe; and according to Vauquelin, it is composed of

Alumina	49
Silica	46
Lime	2
Oxide of iron	1
	98
Loss	2
	100

SONCHUS, in botany, *sow-thistle*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order

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of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx imbricate, ventricose; down hairy; receptacle naked. There are nineteen species.

SONG, in poetry, a little composition, consisting of easy and natural verses, set to a tune in order to be sung.

SONG *of birds*. The song of birds has been defined to be a succession of three or four different notes, which are continued without interruption through the same intervals, in a bar of four crotchets, adagio, or while a pendulum swings four seconds. It is observed, that notes in birds are no more innate than language in man, and that they depend entirely on the master under which they are bred, as far as their organs will enable them to imitate the sounds which they have frequent opportunities of hearing; and their adhering so steadily, even in a wild state, to the same song, is entirely owing to the nestlings attending only to the instruction of the parent-bird, whilst they disregard the notes of all others that may perhaps be singing round them. Birds, in a wild state, do not commonly sing more than six or seven months out of the twelve; but birds that are caged, and have plenty of food, sing the greatest part of the year; and we may add, that the female of no species of birds ever sings. It has been remarked, that there is no instance of any bird singing, whose size exceeds that of our black-bird; and this is supposed to arise from the difficulty it would have of concealing itself, did it call the attention of its enemies, not only by its bulk, but by the proportionable loudness of its notes. It has been noticed by some writers, that certain passages of the song in a few kinds of birds correspond with the intervals of our scale, of which indeed the cuckoo affords a striking and well known instance; but much the greater part of such song is not capable of musical notation; partly because the rapidity is often so great, and it is also so uncertain when they may stop, that we cannot reduce the passages to the form of any musical bar whatsoever; partly also because the pitch of most birds is considerably higher than that of the shrillest notes of our highest instruments; and principally because the intervals used by birds are commonly so minute, and consequently so different from the more gross intervals into which we divide our octave, that we cannot judge of them. Most people, who have not attended to the notes of birds, suppose that all those of the same species sing exactly the same notes and passages, which is by no means true, though it must be admitted that there is a general resemblance. Thus the London bird-catchers prefer the song of the Kentish goldfinches, and Essex chaffinches; but some of the nightingale-fanciers prefer a Surry bird to one of Middlesex. The nightingale has been almost universally esteemed the most capital of singing birds; and its superiority chiefly consists in the following particulars: its tone is much more mellow than that of any other bird, though, by the exertion of its powers, it can be extremely brilliant. Another point of superiority is its continuance of song without a pause, which is often extended to twenty seconds.

SONG, in music, is applied in general to a single piece of music, whether contrived for the voice or an instrument. A song has been compared to an oration; for as, in this latter, there is a subject, viz. some person or thing the discourse is referred to, and which is always to be kept in view through the whole; so, in every regular and melodious song, there is one note which regulates the rest; wherein the song begins, and at last ends: and which is, as it were, the principal matter, or musical subject, to be regarded in the whole course of the song; and this principal or fundamental note is called the key of the song.

SONNERATIA, in botany, so named in memory of Mons. Sonnerat, a genus of the Icosandria Monogynia class and order. Natural order of Hesperideæ. Myrti, Jussieu. Essential character: calyx six-cleft; petals six, lanceolate; berry many-celled, with several seeds in each cell. There is but one species, *viz.* S. acida, a native of the Molucca islands and the bogs of New Guinea; also of Cochin China, on the banks of rivers.

SOOT, a volatile matter, arising from wood, and other fuel, along with the smoke; or rather, it is the smoke itself, fixed and gathered on the sides of the chimney.

SOPHISM, in logic, &c. an argument which carries much of the appearance of truth, and yet leads into error. There is some need of a particular description of these fallacious arguments, that we may with more ease and readiness detect and solve them. 1. The first sort of sophism is called "ignoratio elenchi;" or a mistake of the question. 2. The next sophism is called "petitio principii," or a supposition of what is not granted. 3. That sort of

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fallacy, which is called a circle, is very near a-kin to the "petitio principii." 4. The next sort af sophism is called "non causa pro causa," or the assignation of a false cause. 5. The next is called "fallacia accidentis," or a sophism, wherein we pronounce concerning the nature and essential properties of any subject, according to something which is merely accidental to it. 6. The next sophism borders upon the former; and that is, when we argue from that which is true, absolutely, simply, and abstracted from all circumstances; this is called, in the schools, a sophism "a dicto secundum quid ad dictum simpliciter." This sort of sophism has also its reverse; as, when we argue from that which is true, simply and absolutely, to prove the same thing true in all particular circumstances whatsoever. 7. The sophisms of composition and division come next to be mentioned. The sophism of composition is, when we infer any thing concerning ideas in a compound sense, which is only true in a divided sense. The sophism of division is, when we infer the same thing concerning ideas in a divided sense, which is only true in a compounded one. This sort of sophism is committed, when the word *all* is taken in a collective and distributive sense, without a due distinction. It is the same fallacy, when the universal word *all*, or *no*, refers to species in one proposition, and to the individuals in another. 8. The last sort of sophisms arises from our abuse of the ambiguity of words, which is the largest and most extensive kind of fallacy; and, indeed, several of the former fallacies might be reduced to this head. When the words or phrases are plainly equivocal, they are called sophisms of equivocation. This sophism, as well as the foregoing, and all of the like nature, are solved, by showing the different senses of the words, terms, or phrases.

Bnt where such gross equivocations and ambiguities appear in arguments, there is little danger in imposing on ourselves or others; the greatest danger, and what we are perpetually exposed to in reasoning, is, where the two senses or significations of one term are near a-kin, and not plainly distinguished; and yet are sufficiently different in their sense to lead us into great mistakes, if we are not watchful. And, indeed, the greatest part of controversies, in the sacred or civil life, arise from the different senses that are put upon words, and the different ideas conveyed by them.

SOPHORA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx five-toothed, gibbous above; corolla papilionaceous, with the wings of the same length with the standard; legume. There are twenty-five species.

SORBUS, in botany, *mountain-ash*, a genus of the Icosandria Trigynia class and order. Natural order of Pomaceæ. Rosaceæ, Jussieu. Essential character: calyx five-cleft; petals five; berry inferior; three-seeded. There are three species.

SOREX, the *shrew*, in natural history, a genus of Mammalia of the order Feræ. Generic character: in the upper jaw two front teeth long and bifid; in the lower two or four, the intermediate ones shorter; several tusks on each side; grinders cuspidated. This genus of animals is most nearly allied to that of the mouse. Its teeth, however, constitute an important variation, and class it rather with the carnivorous tribes. There are seventeen species, of which the following most deserve attention. S. araneus, or the fetid shrew, is found throughout Europe and the north of Asia, and inhabits fields, gardens and out-houses, and measures about two inches and a half in length, exclusively of its tail. It is distinguished from a mouse chiefly by a long and sharp snout. It breeds in holes under banks, feeds on roots and grain, as well as on every species of putrid animal substance, and has a very rank and disagreeable odour, whence it derives its designation.

S. moschatus, or the musky shrew, abounds in the north of Europe and Asia, and inhabits principally the river Volga, rarely appearing on land. It is about seven inches long to the tail, and of a cinereous brown colour. Its snout is extremely prolonged, and apparently cartilaginous. It feeds on worms, water-insects and leeches, and sometimes on vegetables. These animals are often observed swimming on rivers and lakes in large companies. On land their motions are particularly slow. They are destroyed in Russia, to be placed in drawers or chests, from which they effectually keep moths at a distance. See Mammalia, Plate XX. fig. 3.

S. radiatus, or the radiated shrew, is a native of Canada, and is remarkable for having on the extremity of its snout a circle of sharp pointed processes, somewhat like the radius of a boot-spur; for

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having its tail most curiously knotted, somewhat resembling what are called Queen's garters; and for having its feet with five toes, each covered with scales. It burrows like the mole, but is seen far more frequently above ground. See Mammalia, Plate XX. fig. 2.

S. cæruleus, or the perfuming shrew, is found in India, and is stated to leave an intolerable musky scent on every substance over which it passes; and it has been asserted by gentlemen of respectability, that a corked bottle of wine has been so completely penetrated by this effluvium, as totally to spoil the liquor. The great strength and subtlety of the perfume are, at all events, unquestionable. This animal prefers rice to almost all other food, living chiefly in the rice fields, but occasionally entering houses.

S. exilis, or the pigmy shrew, abounds in Siberia, is shaped and coloured like the common shrew, and is noticed here for being probably the very smallest of European quadrupeds, being about half a dram only in weight. See Mammalia, Plate XX. fig. 1.

SORITES, in logic, a species of reasoning, in which a great number of propositions are so linked together, that the predicate of the one becomes continually the subject of the next following, till at last a conclusion is formed, by bringing together the subject of the first proposition and the predicate of the last; such is the following argument, "God is omnipotent; an omnipotent being can do every thing possible; a being that can do every thing possible, can do whatever involves not a contradiction; therefore, God can do whatever involves not a contradiction." This combination of propositions may be continued to any length we please, without in the least weakening the ground upon which the conclusion rests; and the reason is, because the sorites may be resolved into as many simple syllogisms as there are middle terms in it: and the conclusion of the last syllogism is universally found to be the same with the conclusion of the sorites.

SOUND, or Hearing, *sense of.* The sense of sight is effected by rays of light, proceeding from the different objects to the retina. The sense of feeling is effected by the contact of its various objects with the body, or by the vigorous or unsound state of the parts of the body. The sense of taste is affected by certain particles of substances which are dissolved by the saliva, and thus brought into contact with the organs of taste. The sense of smell is affected by particles which various substances are continually sending into the air, and which impress the membrane which lines the cavity and bones of the nose. The sense of hearing is affected by the pulsations or vibrations of the air, which are caused by its own expansion, or by the vibrations of sounding bodies. These sensations, or vibrations in the air, are called sounds, as are also the sensations which they produce. The organ of hearing is much more complicated and much less understood, than that of sight. We shall here give a very general account of it, and refer those who wish for further information to the article Anatomy. The external ear collects and modifies sounds; and by a long channel communicates them to the internal ear: this consists, in the first place, of what is called the drum of the ear, which is a small cavity, closed towards the opening of the ear by a delicate membrane. In the drum are three or four very small bones, furnished with muscles and joints. From the drum are several openings, one of which is to the mouth; the others communicate into the different recesses of the ear. One of these leads into the labyrinth, which consists, first, of a small irregular cavity, next of three semi-circular canals, and lastly of a winding spiral canal, not unlike some sea shells. All these parts of the cavity are lined with a very delicate membrane, and filled with a watery fluid, which conveys to the portions of the nerve in contact with it, the vibrations received from the membrane which separates the labyrinth from the drum of the ear. The vibrations of the air act upon the drum, and thus set in motion the series of small bones in the cavity of the drum; these communicate the vibrations to the membrane which separates the drum from the labyrinth, and this (as before mentioned) produces vibrations in the watery fluid, in the several parts of the labyrinth, and conveys to the nervous branches, which line the labyrinth, the vibrations originally produced on the drum. The mechanism is complicated, but what we understand must increase our reverential admiration of the skill which produced it.

There are colours which of themselves, without associated ideas, are agreeable to the sight; so it is reasonable to believe, that there are sounds which of themselves, without associated deas, are agreeable to the ear. This is authorized also by direct experience. All moderate and tolerably uniform sounds please young children; and during the whole of life,

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various combined and simple sounds give pleasure to the mind, without any reference to the associated ideas. Hence it appears that the pleasures of hearing aid considerably in the formation, or at least in the increase, of the mental pleasures: indeed in connection with those of sight, they constitute nearly the whole of the pleasures of sublimity and beauty.

It is a well known fact, that the ideas left by the sensations of sight are the most vivid and distinct of any: next to these are those produced by the sensation of hearing. Few can form a distinct, certainly not a vivid, conception of the feel of any substance, which has presented sensations through the medium of the touch, and not many more can of a taste, or of a smell, though thinking of particular taste produces considerable effusion of the saliva. Of objects of the sight we are able to form conceptions, which often approach in vividness and distinctness to the original sensations, and which sometimes overpower those actually present in the mind, so as in many cases to lead to the belief of a real object, and consequently to lead to the belief of apparitions, &c. Few, we believe, possess the power of forming conceptions of sounds nearly equal in vividness and distinctness with the original sensation; but they are frequently perceptible. After we have heard music, or conversed much with a person, trains of audible ideas frequently pass in the mind. So, when we are thinking or reading slowly and carefully, we can generally trace the relics of the audible impressions of the words suggested by the thoughts, or the sight of the letters; that is, we have faint conceptions of the sounds of these words.

The necessity of hearing to man, considered as a social being, is obvious; its importance to him, considered as a being whose pleasures and pains are by degress to be purely mental, is not inferior. The means of knowledge are greatly diminished by the loss of sight; but the loss of sight only impedes the progress of the mind from sensation to thought and feeling. Those who have never heard have much greater disadvantages to undergo. Their deficiencies can never be fully supplied. Words, as Hartley suggests, are highly important, and even necessary, to the full improvement of intellect, and the enlargement of the affections; and therefore the ear is of much more importance to us, as spiritual beings, than the eye.

To illustrate the cause of sound, it is to be observed, 1st. That a motion is necessary in the sonorous body for the production of sound. 2dly, That this motion exists first in the small and insensible parts of the sonorous bodies, and is excited in them by their mutual collision against each other, which produces the tremulous motion so observable in bodies that have a clear sound, as bells, musical chords, &c. 3dly, That this motion is communicated to, or produces a like motion in the air, or such parts of it as are fit to receive and propagate it. Lastly, That this motion must be communicated to those parts that are the proper and immediate instruments of hearing. Now that motion of a sonorous body, which is the immediate cause of sound, may be owing to two different causes; either the percussion between it and other hard bodies, as in drums, bells, chords, &c. or the beating and dashing of the sonorous body and the air immediately against each other, as in flutes, trumpets, &c. But in both these cases, the motion, which is the consequence of the mutual action, as well as the immediate cause of the sonorous motion which the air converys to the ear, is supposed to be an invisible, tremulous, or undulating motion, in the small and insensible parts of the body.

The sonorous body having made its impression on the contiguous air, that impression is propagated from one particle to another, according to the laws of pneumatics. A few particles, for instance, driven from the surface of the body, push or press their adjacent particles into a less space; and the medium, as it is thus rarefied in one place, becomes condensed in the other; but the air thus compressed in the second place is, by its elasticity, returned back again, both to its former place and its former state; and the air contiguous to that is compressed; and the like obtains, when the air less compressed, expanding itself, a new compression is generated. Therefore, from each agitation of the air there arises a motion in it, analogous to the motion of a wave on the surface of the water, which is called a wave or undulation of air. In each wave, the particles go and return back again through very short equal spaces; the motion of each particle being analogous to the motion of a vibrating pendulum, while it performs two oscillations; and most of the laws of the pendulum, with very little alteration, being applicable to the former.

Sounds are as various as are the means that concur in producing them. The

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chief varieties result from the figure, constitution, quantity, &c. of the sonorous body; the manner of percussion, with the velocity, &c. of the consequent vibrations; the state and constitution of the medium; the disposition, distance, &c. of the organ; the obstacles between the organ and the sonorous object and the adjacent bodies. The most notable distinction of sounds arising from the various degrees and combinations of the conditions above mentioned, are into loud and low (or strong and weak;) into grave and acute (or sharp and flat, or high and low;) and into long and short. The management of which is the office of music.

Euler is of opinion, that no sound making fewer vibrations than 30 in a second, or more than 7520, is distinguishable by the human ear. According to this doctrine, the limit of our hearing, as to acute and grave, is an interval of eight octaves. The velocity of sound is the same with that of the aerial waves, and does not vary much, whether it go with the wind or against it. By the wind indeed a certain quantity of air is carried from one place to another; and the sound is accelerated while its waves move through that part of the air, if their direction be the same as that of the wind. But as sound moves vastly swifter than the wind, the acceleration it will hereby receive is but inconsiderable; and the chief effect we can perceive from the wind is, that it increases and diminishes the space of the waves, so that by help of it the sound may be heard to a greater distance than otherwise it would.

That the air is the usual medium of sound, appears from various experiments in rarefied and condensed air. In an unexhausted receiver, a small bell may be heard to some distance; but when exhausted, it can scarce be heard at the smallest distance. When the air is condensed, the sound is louder in proportion to the condensation, or quantity of air crowded in; of which there are many instances in Hauksbee's experiments, in Dr. Priestley's, and others. Besides, sounding bodies communicate tremors to distant bodies; for example, the vibrating motion of a musical string puts others in motion, whose tension and quantity of matter dispose their vibrations to keep time with the pulses of air, propagated from the string that was struck. Galileo explains this phenomenon, by observing, that a heavy pendulum may be put in motion by the least breath of the mouth, provided the blasts be often repeated. and keep time exactly with the vibrations of the pendulum; and also by the like art in raising a large bell.

It is not air alone that is capable of the impressions of sound, but water also; as is manifest by striking a bell under water, the sound of which may plainly enough be heard, only not so loud, and also a fourth deeper, according to good judges in musical notes. And Mersenne says, a sound made under water is of the same tone or note as if made in air, and heard under the water. The velocity of sound, or the space through which it is propagated in a given time, has been very differently estimated by authors who have written concerning this subject. Roberval states it at the rate of 560 feet in a second; Gassendus at 1473; Mersenne at 1474; Duhamel, in the History of the Academy of Sciences at Paris, at 1338; Newton at 968; Derham, in whose measure Flamstead and Halley acquiesce, at 1142. The reason of this variety is ascribed by Derham, partly to some of those gentlemen using strings and plummits instead of regular pendulums; and partly to the too small distance between the sonorous body and the place of observation; and partly to no regard being had to the winds. But by the account since published by M. Cassini de Thury, in the Memoirs of the Royal Academy of Sciences at Paris, 1738, where cannon were fired at various as well as great distances, under many varieties of weather, wind, and other circumstances, and where the measures of the different places had been settled with the utmost exactness, it was found that sound was propagated on a medium, at the rate of 1038 French feet in a second of time. But the French foot is in proportion to the English as 15 to 16: and consequently 1038 French feet are equal to 1107 English feet. Therefore the difference of the measures of Derham and Cassini is 35 English feet, or 33 French feet, in a second. The medium velocity of sound, therefore, is nearly at the rate of a mile, or 5280 feet, in $4\frac{2}{3}$ seconds, or a league in 14 seconds, or 13 miles in a minute. But sea miles are to land miles nearly as 7 to 6; and therefore sound moves over a sea mile in $5\frac{1}{3}$ seconds nearly, or a sea league in 16 seconds. Further, it is a common observation, that persons in good health have about 75 pulsations, or beats of the artery at the wrist, in a minute; conse-

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quently, in 75 pulsations, sound flies about 13 land miles, or $11\frac{1}{7}$ sea miles, which is about 1 land mile in 6 pulses, or one sea mile in 7 pulses, or a league in 20 pulses. And hence the distance of objects may be found, by knowing the time employed by sound in moving from those objects to an observer. For example. On seeing the flash of a gun at sea, if 54 beats of the pulse at the wrist were counted before the report was heard, the distance of the gun will easily be found by dividing 54 by 20, which gives 2.7 leagues, or about 8 miles. See ACOUSTICS.

SOUND, in geography, denotes in general any strait, or inlet of the sea, between two head lands. However, the name sound is given by way of eminence, to the strait between Sweden and Denmark, joining the German Ocean to the Baltic, being about four miles over.

SOUND *board*, in an organ, is a reservoir, into which the wind, drawn in by the bellows, is conducted by a port-vent, and hence distributed into the pipes placed over holes in its upper part: this wind enters them by valves, which open by pressing upon the stops or keys, after drawing the registers, which prevent the air from entering any of the pipes, except those it is required in.

SOUNDING, the operation of trying the depth of the water, and the quality of the ground, by means of a plummit sunk from a ship to the bottom. For sounding there are two plummits used, one of which is called the hand lead, weighing about eight or nine pounds; and the other, the deep-sea lead, weighing from twenty-five to thirty pounds, and both are shaped like the frustrum of a cone or pyramid. The former is used in shallow waters, and the latter at a great distance from the shore, particularly on approaching the land after a sea voyage. Accordingly, the lines employed for this purpose are called the deep-sea lead and the hand-lead line. The hand-lead line, which is generally twenty fathoms in length, is marked at every two or three fathoms, so that the depth of water may be ascertained either in the day or night. At the depth of two and three fathoms, there are marks of black leather; at five fathoms there is a white rag; at seven, a red rag; at ten, black leather; at thirteen, black leather; at fifteen, a white rag; and at seventeen, a red rag.

Sounding with the hand-lead, which is called heaving the lead by seamen, is generally performed by a man who stands in the main-chains to windward. Having the line all ready to run out without interruption, he holds it nearly at the distance of a fathom from the plummit, and having swung the latter backwards and forwards three or four times, in order to acquire the greater velocity, he swings it round his head, and thence as far forward as is necessary; so that, by the lead's sinking while the ship advances, the line may be almost perpendicular when it reaches the bottom. The person sounding then proclaims the depth of the water in a kind of song resembling the cries of London hawkers. Thus, if the mark of five fathoms is close to the surface of the water, he calls, "By the mark five," and as there is no mark at four, six, eight, &c. he estimates those numbers and calls, "By the dip four." If he judges it to be a quarter or an half more than any particular number he calls, "And a quarter five—and a half four," &c. If he conceives the depth to be three quarters more than a particular number, he calls it a quarter less than the next: thus, at four fathoms and three quarters he calls, "A quarter less five," &c.

The deep-sea lead is marked with two knots at twenty fathoms, three at forty, four at fifty, and so on to the end. It is also marked with a single knot in the middle of each interval, as at twenty-five, thirty-five, forty-five, fathoms, &c. To use this lead more effectually at sea, or in deep water on the sea coast, it is usual previously to bring-to the ship, in order to retard her course; the lead is then thrown as far as possible from the ship, on the line of her drift, so that, as it sinks, the ship drives more perpendicularly over it. The pilot, feeling the lead strike the bottom, readily discovers the depth of the water by the mark on the line nearest is surface.

SOUP, a strong decoction of flesh or other substances. Portable or dry soup is a kind of a cake, formed by boiling the gelatinous parts of animal substances till the watery parts are evaporated. This species of soup is cheafly used at sea, and has been found of great advantage. The following receipt will show how it is prepared: Of calves feet take four, leg of beef twelve pounds, knuckle of veal three pounds, and leg of mutton ten pounds. These are to be boiled in a sufficient quantity of water, and the scum taken off as usual; after which the soup is to be separated from the meat by straining and pressure. The meat is then to be boiled a second time in other water; and the two decoctions, being added together, must

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be left to cool, in order that the fat may be exactly separated. The soup must then be clarified with five or six whites of eggs, and a sufficient quantity of common salt added. The liquor is then strained through flannel, and evaporated on the water-bath to the consistence of a very thick paste; after which it is spread rather thin upon a smooth stone, then cut into cakes, and lastly dried in a stove till it becomes brittle: these cakes are kept in well closed bottles. The same process may be used to make a portable soup of the flesh of poultry; and aromatic herbs may be used as a seasoning, if thought proper. These tablets, or cakes, may be kept four or five years: when intended to be used, the quantity of half an ounce is put into a large glass of boiling water, which is to be covered and set upon hot ashes for a quarter of an hour, or until the whole is entirely dissolved. It forms an excellent soup, and requires no addition but a small quantity of salt.

SOUTHING *of the Moon*, the time at which the Moon passes the meridian of any particular place.

SOW, in zoology, the female of the hog-kind. See Sus.

Sow, in the iron-works, the name of the block or lump of metal they work at once in the iron furnace. The size of these sows of iron is very different, even from the same workmen, and the same furnace. These furnaces having sand stones for their hearths and sides up to the height of a yard, and the rest being made of brick, the hearth by the force of the fire is continually growing wider, so that if it at first contains as much metal as will make a sow of six or seven hundred weight, it will at last contain as much as will make a sow of two thousand weight.

SPACE, is defined by Mr. Locke to be a simple idea, which we attain both by our sight and touch: the modes whereof are distance, capacity, extension, duration, &c. Space, considered barely in length between two bodies, is the same idea which we have of distance. If it be considered in length, breadth and thickness, it is properly called capacity; when considered between the extremities of matter, which fills the capacity of space with something solid, tangible, and moveable, it is then called extension, so that extension is an idea belonging to a body, but space, it is plain, may be conceived without it. Each different distance is a different modification of space, and each idea of any different space is a simple mode of this idea: such are, an inch, foot, yard, &c. which are the ideas of certain stated lengths, which men settle in their minds for the use, and by the custom of measuring. When these ideas are made familiar to men's thoughts, they can repeat them as often as they will, without joining to them the idea of the body, and frame to themselves the ideas of feet, yards, or fathoms, beyond the utmost bounds of all bodies; and by adding these still one to another, enlarge their idea of space as much as they please. From this power of repeating any idea of distance without ever coming to an end, we come by the idea of immensity. Another modification of space is taken from the relation of the termination of the parts of extension, or circumscribed space, amongst themselves; and this is what we call figure. This the touch discovers in sensible bodies, whose extremities come within our reach; and the eye takes both from bodies and colours, whose boundaries are within its view; where, observing how the extremities terminate, either in straight lines, which meet at discernible angles, or in crooked ones, wherein no angles can be perceived, by considering these as they relate to one another in all parts of the extremities of any body or space, it has that idea we call figure, which affords to the mind infinite variety. Another mode belonging to this head is that of place. There is another mode of space, the idea of which we get from the fleeting and perpetually perishing parts of succession, which we call duration. Space is usually divided into absolute and relative. Absolute space is that considered in its own nature, without regard to any thing external, which always remains the same, and is infinite and immoveable. Relative space, is that moveable dimension, or measure of the former, which our senses define by its positions to bodies within it, and this is the vulgar use for immoveable space. Relative space, in magnitude and figure, is always the same with absolute; but it is not necessary it should be so numerically; as if you suppose a ship to be, indeed, in absolute rest, then the places of all things within her will be the same, absolutely and relatively, and nothing will change its place: but suppose the ship under sail, or in motion, and she will continually pass through new parts of absolute space; but all things on board, considered relatively in respect to the ship, may be, notwithstanding, in the same places, or have the same situation and position in regard to one another.

SPACE, in geometry, denotes the area of

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any figure, or that which fills the interval or distance between the lines that terminate it.

Space, in mechanics, the line a moveable body, considered as a point, is conceived to describe by its motion.

SPADIX, in botany, a term formerly applied to the receptacle of the palms: it is now used to express every flower stalk that is protruded out of a spatha or sheath.

SPAN, a measure taken from the space between the thumb's end and the tip of the little fingure, when both are stretched out. The span is estimated at three hand's breadths or nine inches.

Span, in naval affairs, a small line or cord, the middle of which is usually attached to a stay, whence the two ends branch outwards to the right and left, having either a block or thimble attached to their extremities.

SPAR, a name given to those earths which break easily into rhomboidal, cubical, or laminated fragments, with polished surfaces. As the term spar is thus applied to stones of different kinds, without any regard to the ingredients of which they are composed, some additional term must be used to express the constituent parts as well as the figure. The spars found in Britain and Ireland are of four different species: opaque, refracting, diaphanous, and stalactical. A species of spar has also been found in the East Indies, which, from its extreme hardness, approaching to that of a diamond, is called adamantine spar. It was discovered by Dr. Black, of Edinburgh, to be a distinct species. There are two varieties; one of them comes from China, and crystallizes in hexagonal prisms without pyramids, the length of the sides varying from six to twelve lines, their breadth being about nine, of a grey colour, with different shades. Though the entire pieces are opaque, the thin laminæ are transparent, and, when broken, its surfaces appear slightly striated. Its crystals are covered with a very fine and strongly adhering crust, composed of scales of silvery mica, mixed with particles of red felspar. Sometimes the surface has martial pyrites or yellow sulphuret of iron adhering to it. Its hardness is so great, that it not only cuts glass as easily as the diamond, but even scratches rock crystal and other very hard stones. Its specific gravity is to that of water as 2.7 to 1.0. Sometimes it contains crystallized grains of magnetic oxide of iron, which may be separated from the stone, when pulverized, by means of the loadstone. The other kind, found in Hindoostan, is of a whiter colour, and of a more laminated texture than the former. The grains of iron contained in it are likewise a smaller size than those of the former; they are not diffused through its substance, but only adhere to its surface. This spar is exceedingly difficult to analyze. M. Morveau appears to have ascertained that this stone is also found in France. A small bit of it was tried in the presence of Mr. Wedgewood, and he found that its specific gravity was superior to the spar of China, being no less than 4.18, and the true adamantine spar of China gave 3.82.

Although the word spar seems to include almost all the earthy crystallized minerals that are met with in metallic veins, yet mineralogists have generally agreed to apply the term to those minerals, whether earthy or metallic, which are crystallized, and have a visible foliated texture. Hence we have felspar-spar, fluor-spar, &c. Some of the spars have already been described in their alphabetical order; others we shall enumerate here.

Spar, *cube*, is of a milk-white colour, which passes sometimes into a greyish-white, and even into a reddish-white. It is massive; the lustre is shining, passing to splendent, and perfectly pearly. The fragments are cubical. Specific gravity is 2.9. It is found in salt rocks in the Archbishoprick of Salzbourg.

Spar, *diamond*, is of a dark brown colour; it ocurs massive, disseminated, in rolled pieces, and crystallized in six-sided prisms and pyramids: internally its lustre is splendent, and generally pearly, approaching in a slight degree to adamantine. Specific gravity nearly 4. Its constitutent parts are, according to Klaproth,

Alumina	84.0
Silica	6.5
Oxide of iron . . .	7.5
	98.0
Loss	2
	100.0

It is found in China, and supposed to occur in granite. It is used in cutting and polishing hard minerals. It is reckoned to belong to the flint genus.

Spar, *fel*, or Felspar, is a species of the clay genus, divided, by Werner, into four sub-species, *viz.* the compact and the common felspar, adularia and labrador stone.

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Compact felspar is of a grey colour, passing to the white, blue, green, and red. It occurs massive, disseminated in rolled pieces, and in crystals; internally its lustre is sometimes glistening, sometimes glimmering. It is fusible, without addition, before the blow-pipe. It is found in Germany, and many parts of this country, particularly in Scotland, at the Pentland Hills, and Salisbury Craigs, near Edinburgh. It is one of the constituent parts of primitive, transition, and floetz green-stone slate, and is also imbedded in crystals in antique porphyry.

The common felspar is one of the most abundant of fossils, and forms a constituent part of granite and gneiss; it occurs also in sienite, in green-stone, and in imbedded crystals in porphyry, basalt, and porphyry-slate. Its specific gravity is from 2.4 to 2.7. It melts before the blow-pipe, without addition, into a white glass. A specimen, analyzed by Kirwan, was found to consist of

Silica	67.0
Alumina	14.0
Barytes	11.0
Magnesia	8.0
	100.0

Adularia is of a greenish white: is found massive, in rolled pieces, and crystallized. Specific gravity from 2.5 to 2.6. It melts, without addition, before the plow-pipe, into a whitish glass. It is found in veins and cavities, in gneiss and mica slate, and is accompanied with quartz-mica, common felspar, and tourmaline. It consists, according to the analysis of Vauquelin, of

Silica	64
Alumina	20
Lime	2
Potash	14
	100

It is found in the mountain of St. Gothard in Switzerland, and particularly in the summit named Adula, hence its name. See LABRADOR *stone*.

SPAR, *fluor*. See FLUORIC *acid*.

SPAR, *heavy*. See BARYTES. See also RHOMB *spar*, &c.

SPARS, in ship building, large round pieces of timber, fit for making top masts.

SPARGANIUM, in botany, *bur-reed*, a genus of the Monoecia Triandria class and order. Natural order of Calamariæ. Typhæ, Jussieu. Essential character: male and female; ament roundish; calyx three-leaved; corrolla none; female stigma bifid; drupe juiceless, one-seeded. There are three species.

SPARGEL *stone*, or SPARGELSTEIN; called also ASPARAGUS *stone*, which see.

SPARRMANNIA, in botany, so named in memory of Anders, or Andrew Sparrman, a Swede, a genus of the Polyandria Monogynia class and order. Natural order of Columniferæ. Filiaceæ, Jussieu. Essential character: calyx four-leaved; corolla of four reflexed petals; nectary several, torulose; capsule angular, five-celled, echinate. These is only one species, *viz.* S. Africana, a native of the Cape of Good Hope.

SPARROW, in ornithology, a species of the fringilla. See FRINGILLA.

SPARTIUM, in botany, *broom*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx produced downwards; filaments adhering to the germ; stigma longitudinal, villose above. There are twenty-seven species. The S. scoparium, or common broom, is used for a variety of purposes. It has been of great benefit sometimes in dropsical complaints. The manner in which Dr. Cullen administered it was this: he ordered half an ounce of fresh broom tops to be boiled in a pound of water till one half of the water was evaporated. He then gave two table-spoons full of the decoction every hour till it operated both by stool and urine. By repeating these doses every day, or every second day, he says some dropsies have been cured. Dr. Mead relates, that a dropsical patient, who had taken the usual remedies, and had been tapped three times without effect, was cured by taking half a pint of the decoction of queen-broom tops, with a spoonful of whole mustard seed, every morning and evening. "An infusion of the seeds drunk freely (says Mr. Withering) has been known to produce similar happy effects; but whoever expects these effects to follow in every dropsical case, will be greatly deceived. I knew them succeed in one case that was truly deplorable; but out of a great number of cases in which the medicine had a fair trial, this proved a single instance."

The flower-buds are in some countries pickled, and eaten as capers; and the seeds have been used as a bad substitute

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for coffee. The branches are used for making besoms, and tanning leather. They are also used instead of thatch to cover houses. The old wood furnishes the cabinet maker with beautiful materials for vaneering. The tender branches are in some places mixed with hops for brewing, and the macerated bark may be manufactured into cloth.

SPARUS, in natural history, a genus of fishes of the order Thoracici. Generic character: teeth strong, sometimes arranged in a single row, and sometimes in two rows or more; grinders generally convex, smooth, and thickly planted in the mouth like a species of pavement; lips doubled; gill covers unarmed, smooth and scaly. There are forty species, but little is known of their habits and manners, and in some instances, Shaw observes, that they are confounded by naturalists with the genus Labrus. S. auratus, or gilt-headed sparus, is found in the European, American, and Indian seas, is about fifteen inches long, and was admired as a great delicacy by the ancients, by whom it was also consecrated to Venus.

SPATHA, in botany, a *sheath*, a species of calyx which bursts lengthwise, and protrudes a stalk supporting one on more flowers, which commonly have no perianthium or proper flower-cup. The spatha opens on one side, from bottom to top, and consists either of one piece, as in the narcissus, snow drop, and the greater number of spathaceous plants, of two, as in the marsh aloe; or of a number of scales laid over one another like titles, as in the plantain-tree.

SPATHACEÆ, the name of the ninth order in Linnæus's Fragments of a Naturnl Method, consisting of plants, the flowers of which are protruded from a sheath; among these are the allium, onion, galanthus, snow-drop, and narcissus daffodil. The plants of this order are nearly allied in habit and structure to the liliaceous plants, from which they are distinguished by the spatha, or sheath, out of which their flowers are protruded.

SPATHELIA, in botany, a genus of the Pentandria Trigynia class and order. Natural order of Bicornes. Terebintaceæ, Jussieu. Essential character: calyx five-leaved; petals five; capsule three-cornered, three celled; seeds solitary. There is only one species, *viz.* S. simplex, rhus-leaved spathelia, a native of Jamaica.

SPATULA, an instrument used by surgeons and apothecaries.

SPAYING, an operation performed on the females of several kinds of animals, to prevent any further conception, and promote their fattening.

SPEAKER *of the House of Commons*, a member of the house elected by a majority of the votes thereof, to act as chairman or president in putting questions, reading briefs or bills, keeping order, reprimanding the refractory, adjourning the house, &c. The first thing done by the commons, upon the first meeting of a parliament, is to choose a speaker, who is to be approved of by the king, and who, upon his admission, begs his Majesty that the commons, during their sitting, may have free access to his Majesty, freedom of speech in their own house, and security from arrests. The speaker is not allowed to persuade or dissuade in passing a bill, but only to make a short and plain narrative; nor to vote, unless the house be equally divided.

SPECIES, in logic, a relative term, expressing an idea which is comprised under some general one, called a genus. The idea of a species is formed, by adding a new idea to the genus: thus if the genus be a circumscribed space, and we suppose this circumscription to be by lines, we shall obtain the notion of that species of figures which are called plain figures; but if we conceive the circumscription to be by surfaces, we get an idea of the species of solid figures. This superadded idea is called the specific difference, not only as it serves to distinguish the species from the genus; but because, being different in all the several subdivisions, we thereby also distinguish the species one from another: and as this superadded conception completes the notion of the species, it is plain that the genus and specific difference are the proper and constituent parts of the species. If we trace the progress of the mind still further, and observed it advancing through the inferior species, we shall find its manner of proceeding to be always the same; since every lower species is formed, by superadding some new idea to the species next above: thus, if animal be the genus, by superadding the notion of four limbs, we obtain the idea of quadrupeds; if to this we add further, the peculiar form and characters which distinguish mankind, we get the idea of the human species; and by adding the peculiarities which distinguish a particular person from all others, we form the notion of an individual, which is called the last species, or species specialissimum.

For the use of the genus, species, and

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specific difference in defining things, see DEFINITION.

SPECIES, in logic, is one of the five words called by Porphyry universals. See UNIVERSAL.

SPECIES, in rhetoric, is a particular thing, contained under a more universal one.

SPECIES, in commerce, are the several pieces of gold, silver, copper, &c. which, having passed their full preparation and coinage, are current in public.

SPECIES, in algebra, the characters or symbols made use of to represent quanties.

SPECIFIC, in philosophy, that which is peculiar to any thing, and distinguishes it from all others.

SPECIFIC, in medicine, a remedy, whose virtue and effect is peculiarly adapted to some certain disease, is adequate thereto, and exerts its whole force immediately thereon.

SPECIFIC *gravity*, is that by which one body is heavier than another of the same dimension, and is always as the quantity of matter under that dimension. As to the method of finding the specific gravities of bodies, see HYDROSTATICS.

SPECTACLE. See VISION.

SPECTRA, *ocular*. See RETENTION.

SPECTRUM, in optics. When a ray of light is admitted through a small hole, and received on a white surface, it forms a luminous spot. If a dense, transparent body be interposed, the light will be refracted, in proportion to the density of the medium; but if a triangular glass prism be interposed, the light is not merely refracted, but it is divided into seven different rays. The ray of light no longer forms a luminous spot, but has assumed an oblong shape, terminating in semicircular arches, and exhibiting seven different colours. This image is called the spectrum, and from being produced by the prism, the prismatic spectrum. These different coloured rays, appearing in different places of the spectrum, show that their refractive power is different. Those which are nearest the middle are the least refracted, and those which are the most distant the greatest. The order of the seven rays of the spectrum is the following: red, orange, yellow, green, blue, indigo, violet. The red, which is at one end of the spectrum, is the least, and the violet, which is at the other end, is the most refracted. Sir Isaac Newton found, if the whole spectrum was divided into 360 parts, the number of the parts occupied by each of the colours to be the following:

Red	45 parts.
Orange	27
Yellow	48
Green	60
Blue	60
Indigo	40
Violet	80

These different coloured rays are not subject to further division. No change is effected upon any of them by being further refracted or reflected; and as they differ in refrangibility, so also do they differ in the power of inflection and reflection. The violet rays are found to be the most reflexible and inflexible, and the red the least.

SPECULATIVE, something related to the theory of some art or science, in contradistinction to practical.

SPECULUM, a *looking-glass* or *mirror*, capable of reflecting the rays of the sun, &c. See MIRROR and TELESCOPE.

SPECULUM, in surgery, an instrument for dilating a wound, or the like, in order to examine it attentively.

SPERGULA, in botany, spurrey, a genus of the Decandria Pentagynia class and order. Natural order of Caryophyllei. Essential character: calyx five-leaved; petals five, entire; capsule ovate, one-celled, five-valved. There are seven species. The S. arvensis, corn spurrey, has linear-furrowed leaves, from eight to twenty in a whorl. The flowers are small, white, and terminal. It is frequent in corn-fields. In Holland it is cultivated as food for cattle, and has the advantage of growing on the very poorest soils, but does not afford a great deal of food. Poultry are fond of the seeds; and the inhabitants of Finland and Norway make bread of them when their crops of corn fail.

SPERMACETI is found in the head of the Physeter macrocephalus, a species of whale; it is obtained in an unctuous mass, from which oil is obtained by expression. Spermaceti is also found in other cetaceous fishes, and in other parts of the body, mixed with the oil. It is a fine white substance, of a crystallized texture, very brittle, and has little taste or smell. It crystallizes in the form of shining silvery plates. It melts at the temperature of 112°. With a greater heat it may be distilled without change; but, by repeated distillation, it is decomposed, and partly converted into a brown acid liquid. It is soluble in boiling alco-

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hol, but it separates when the solution cools. It is also soluble in ether, both cold and hot. In the hot solution it concretes on cooling into a solid mass. Spermaceti is scarcely at all soluble in the acids. It combines readily with the pure alkalies, with sulphur, and with the fixed oils. By exposure to the air it becomes rancid. The uses of spermaceti are well known, and particularly in the manufacture of candles. Spermaceti differs chiefly from oil, by its solubility in alcohol and ether. According to Dr. Bostock, it requires 150 times its weight of alcohol, boiling hot, to dissolve it, and as the fluid cools, the spermaceti precipitates.

Spermaceti candles are of modern manufacture: they are made smooth, with a fine gloss, free from rings and scars, superior to the finest wax-candles in colour and lustre; and, when genuine, leave no spot or stain on the finest silk, cloth or linen. A method has been lately proposed by Dr. Smith Gibbes, of Magdalen College, Oxford, to convert animal muscle into a substance much resembling spermaceti. The process is remarkably simple: nothing more is necessary than to take a dead carcase and expose it to a stream of running water: it will in a short time be changed to a mass of fatty matter. To remove the offensive smell, a quantity of nitrous acid may then be poured upon it, which, uniting with the fetid matter, the fat is separated in a pure state. This acid indeed turns it yellow, but it may be rendered white and pure by the action of the oxygenated muriatic acid. Dr. Gibbes brought about the same change in a much shorter time. He took three lean pieces of mutton, and poured on them the three mineral acids, and he perceived, that at the end of three days each was much altered; that in the nitrous acid was much softened, and, on separating the acid from it, he found it to be exactly the same with that which he had before got from the water; that in the muriatic acid was not in that time so much altered; the vitriolic acid had turned the other black. See the article ADIPOCIRE.

SPERMACOCE, in botany, *button-weed*, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ, Rubiaceæ, Jussieu. Essential character: corolla one-petalled, funnel-shaped; seeds two, two-toothed. There are twenty species.

SPHÆRANTHUS, in botany, a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx eight-flowered: corolla tubular, hermaphrodite, and indistinct: female receptacle scaly; down none. There are four species.

SPHÆRIA, in botany, a genus of the Cryptogamia Fungi. Generic character: fructifications mostly spherical, opening at the top, whilst young filled with jelly, when old with a blackish powder. They grow on the bark or wood of other plants; capsules often immersed, so that their orifices only are visible: most of the species are without a stem.

SPHÆROCARPUS, in botany, a genus of the Cryptogamia Hepaticeæ. Generic character: calyx ventricose, undivided; seeds numerous, collected into a globe.

SPHAGNUM, in botany, a genus of the Cryptogamia Musci. Generic character: male, flower club-shaped; anthers flat; capsule on the same plant, sessile, covered with a lid, without any entire veil; mouth smooth.

SPHERE, is a solid contained under one uniform round surface, such as would be formed by the revolution of a circle about a diameter thereof, as an axis. Thus the circle AE, BD (see Plate XIV. Miscel. fig. 2.) revolving about the diameter AB, will generate a sphere, whose surface will be formed by the circumference of the circle.

Definitions. 1. The centre and axis of a sphere are the same as the centre and diameter of the generating circle; and as a circle has an indefinite number of diameters, so a sphere may be considered as having also an indefinite number of diameters, round any one of which the sphere may be conceived to be generated. 2. Circles of the sphere are those circles described on its surface, by the motions of the extremities of the chords ED, FG, IH, &c. at right angles to AB; the diameters of which circles are equal to those chords. 3. The poles of a circle on the sphere are those points on its surface, equally distant from the circumference of that circle: thus A and B are the poles of the circles described on the sphere by the ends of the chords ED, FG, IH, &c. 4. A great circle of the sphere is one equally distant from both its poles; as that described by the extremities of the diameter ED, which is equally distant from both its poles A and B. Lesser circles of the sphere are those which are unequally distant from both their poles; as those described by the extremities of the chords FG, HI, &c. because

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unequally distant from their poles A and B. See CIRCLE.

Axioms. 1. The diameter of every great circle passes through the centre of the sphere; but the diameters of all lesser circles do not pass through the same centre: hence also the centre of the sphere is the common centre of all the great circles. 2. Every section of a sphere by a plane, is a circle. 3. A sphere is divided into two equal parts, or hemispheres, by the plane of every great circle: and into two unequal parts, called segments, by the plane of every lesser circle. 4. The pole of every great circle is 90° distant from it on the surface of the sphere; and no two great circles can have a common pole. 5. The poles of a great circle are the two extremities of that diameter of the sphere, which is perpendicular to the plane of that circle. 6. A plane passing through three points on the surface of the sphere, equally distant from any of the poles of a great circle, will be parallel to the plane of that great circle. 7. The shortest distance between two points, on the surface of a sphere, is the arch of a great circle passing through these points. 8. If one great circle meets another, the angles on either side are supplements to each other; and every spherical angle is less than 180°. 9. If two circles intersect each other, the opposite angles are equal. 10. All circles on the sphere, having the same pole, are cut into similar arches, by great circles passing through that pole.

SPHERE, *properties of the.* 1. All spheres are to one another as the cubes of their diameters. 2. The surface of a sphere is equal to four times the area of one of its great circles, as is demonstrated by Archimedes in his book of the Sphere and Cylinder, lib. i. prop. 37. Hence, to find the superficies of any sphere, we have this easy rule; let the area of a great circle be multiplied by 4, and the product will be the superficies: or, according to Euclid, lib. vi. prop. 20. and lib. xii. prop. 2. the area of a given sphere, CEBD (fig. 3.) is equal to that of a circle, whose radius is equal to the diameter of the sphere BC. Therefore, having measured the circle described with the radius BC, this will give the surface of the sphere. 3. The solidity of a sphere is equal to the surface multiplied into one third of the radius: or, a sphere is equal to two thirds of its circumscribing cylinder, having its base equal to a great circle of the sphere. Let ABEC (fig. 4 and 5.) be the quadrant of a circle, and ABDC the circumscribed square, equal twice the triangle ADC: by the revolution of the figures about the right line AC, as an axis, a hemisphere will be generated by the quadrant, a cylinder of the same base and height of the square, and a cone by the triangle: let these three be cut any how by the plane HF, parallel to the base AB; and the section of the cylinder will be a circle, whose radius is FH; in the hemisphere, a circle whose radius is FE; and in the cone, a circle of the radius FG. But EA^2 ($=HF^2$) $= EF^2 + FA^2$: but $AF^2 = FG^2$, because $AC = CD$; and therefore $HF^2 = EF^2 + FG^2$; or the circle of the radius HF is equal to a circle of the radius EF, together with a circle of the radius GF: and since this is true every where, all the circles together described by the respective radii HF, that is, the cylinder, are equal to all the circles described by the respective radii EF and FG, that is, to the hemisphere and cone taken together. But by Euclid. lib. xii. prop. 10. the cone generated by the triangle DAC, is one third part of the cylinder generated by the square BC; whence it follows, that the hemisphere generated by the rotation of the quadrant ABEC, is equal to the remaining two-thirds of the cylinder, and that the whole sphere is two-thirds of the cylinder circumscribed about it. Hence it follows, that a sphere is equal to a cone whose height is equal to the semi-diameter of the sphere, and its base equal to the superfices of the sphere, or to the area of four great circles of the sphere, or to that of a circle, whose radius is equal to the diameter of the sphere.

SPHERE, in astronomy, that concave orb, or expanse, which invests our globe, and in which the heavenly bodies appear to be fixed, and at an equal distance from the eye. The better to determine the places of the heavenly bodies in the sphere, several circles are supposed to be described on the surface thereof, hence called the circles of the sphere: of these, some are called great circles, as the equinoctial, ecliptic, meridian, &c. and others, small circles, as the tropics, parallels, &c. See each under its proper article.

SPHERICS, is that part of geometry which treats of the position and mensuration of arches of circles described on the surface of a sphere. See SPHERE.

SPHEROID, in geometry, a solid, approaching to the figure of a sphere.

The spheroid is generated by the entire revolution of a semi-ellipsis about its axis. Thus, if the semi-ellipsis AHFB

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(Plate XIV. Miscel. fig. 6.) be supposed to revolve round its transverse axis AB, it will generate the oblong spheroid AHFBC. Now as all circles are as the squares described upon their radii, that is, the circle of the radius EH is to the circle of the radius EG, as CF^2 to CD^2, because EH : EG : : CF : CD, and since it is so every where, all the circles described with the respective radii EH, (that is, the spheroid made by the rotation of the semi-ellipsis AFB about the axis AB) will be to all the circles described by the respective radii EG, (that is, the sphere described by the rotation of the semicircle ABD on the axis AB,) as FC^2 to CD^2; that is, as the spheroid is to the sphere on the same axis, so is the other axis of the generating ellipsis to the square of the diameter or axis of the sphere: and this holds, whether the spheroid be formed by a revolution around the greater or lesser axis.

Hence it appears, that the half of the spheroid, formed by the rotation of the space AHFC, around the axis AC, is double of the cone generated by the triangle AFC, about the same axis. Hence, also, is evident the measure of segments of the spheroid, cut by planes perpendicular to the axis: for the segment of the spheroid, made by the rotation of the space ANHE round the axis AE, is to the segment of the sphere, having the same axis AC, and made by the rotation of the segment of the circle AMGE, as CF^2 to CD^2. But the measure of this solid may be found with less trouble by this analogy; *viz.* as BE : AC + EB : : so is the cone generated by the rotation of the triangle AHE round the axis AE; to the segment of the sphere made by the rotation of the space ANHE round the same axis AE, as is demonstrated by Archimedes of conoids and spheroids, prop. 34. This agrees as well to the oblate as to the oblong spheroid. A spheroid is also equal to two thirds of its circumscribing cylinder. As to the superficies of a spheroid, M. Huygens gives the two following constructions in his Horolog. Oscill. For describing a circle equal to the superficies of an oblong and prolate spheroid: 1. Let an oblong spheroid be generated by the rotation of the ellipsis ADBE, (fig. 7.) about its transverse axis AB, and let DE be its conjugate; make DF equal to CB, or let F be one of the foci, and draw BG parallel to FD, and about the point G, with the radius BG, describe an arch, BHA, of a circle; then between the semi-conjugate CD, and a right line equal to DE + the arch AHB, find a mean proportional, and that will be the radius of a circle equal to the superficies of the oblong spheroid. 2. Let a prolate spheroid be generated by the rotation of the ellipsis ADBE (fig. 8.) about its conjugate axis AB. Let F be one of the foci, and bisect CF in G, and let AGB be the curve of the common parabola, whose base is the conjugate diameter AB, and axis CG. Then if between the transverse axis DE, and a right line equal to the curve AGB of the parabola, a mean proportional be taken, the same will be the radius of a circle equal to the surface of that prolate spheroid.

SPHEX, in natural history, a genus of insects of the order Hymenoptera. Mouth with an entire jaw, the mandibles horny, incurved, toothed; lip horny, membranaceous at the tip; four feelers; antennæ with about ten articulations; wings, in each sex, plane, incumbent, and not folded; sting pungent, and concealed within the abdomen. There are about one hundred and fifty species, divided into sections. A. antennæ setaceous: an entire lip and no tongue. B. antennæ filiform; lip emarginate, with a bristle on each side; tongue inflected, trifid. The insects of this genus are the most savage and rapacious of this class of beings: they attack whatever comes in their way, and by means of their poisonous sting overcome and devour others far beyond their own size. Those belonging to section B are found chiefly on umbellate plants: the larva is without feet, soft, and inhabits the body of some other insect, on whose juices it exists: the pupa has rudiments of wings.

S. maculata, is found in England. Thorax spotted; first segment of the abdomen with a white dot on each side; second, edged with white. See Plate IV. Entomology, fig. 6.

S. figulus, an inhabitant of Upsal, is smooth and black; segments of the abdomen at the edges and lip lucid. It is found in holes of wooden partitions, abandoned by other insects; these it cleanses by gnawing round them, and, placing a piece of moist clay at the bottom, sticks a spider upon it; in the body of this spider it deposits its eggs, and then closes up the entrance with clay, and leaves it to be devoured by the larva.

S. spirifex, is black; thorax hairy, immaculate; petiole of one joint yellow, as long as the abdomen. This insect is found in Egypt, and in several parts of

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Europe, in cylindrical cavities, wrought within like a honey-comb, on the sides of cliffs, and in the mud walls of cottages.

S. figulus, is one of the species mentioned by Dr. Shaw This insect, having found some convenient cavity, seizes a spider, and having killed it, deposits it at the bottom; then laying her egg in it, she closes up the orifice of the cavity with clay; the larva, which resembles the maggot of a bee, having devoured the spider, spins itself up in a dusky silken web, and changes into a chrysalis, out of which, within a certain number of days, proceeds the complete insect. The female of this species prepares several separate holes, or nests, in each of which she places a dead insect and an egg; each cell costing her the labour of about two days.

SPHINCTER, in anatomy, a term applied to a kind of circular muscles, or muscles in form of rings, which serve to close and draw up several orifices of the body, and prevent the excretion of the contents: thus the sphincter of the anus closes the extremity of the intestinum rectum.

SPHINX, in natural history, *hawk-moth*, a genus of insects of the order Lepidoptera. Antennæ somewhat prismatic, tapering at each end; tongue mostly exserted; two feelers, reflected; wings deflected. There are about two hundred species; these fly abroad in the morning and evening, are very slow on the wing, and often make a humming kind of noise; they extract the nectary of flowers with the tongue: the larva has sixteen feet; and is pretty active. The name of the sphinx is applied to the genus, on account of the posture assumed by the larvæ of several of the larger species, which are said to be seen in an attitude much resembling that of the Egyptian sphinx. This numerous genus is divided into sections: A. antennæ scaly: feelers hairy; tongue spiral. B. antennæ cylindrical; tongue exserted, truncate; wings entire. C. antennæ thicker in the middle; tongue exserted. The largest, and perhaps the most beautiful of the European species, is S. atropos; of this, the upper wings are of a fine dark grey, with a few slight variegations of dull orange and white; the body is orange coloured, with the sides marked with black bars, while along the top of the back, from the thorax to the tail, runs a broad blue-grey stripe; on the top of the thorax is a very large patch, of a most singular appearance, exactly resembling the usual figure of a skull When in the least disturbed, or irritated, this insect emits a sound like the squeaking of a mouse or a bat. In many parts of Europe it is held much in dread by the vulgar, and regarded as the harbinger of misfortune. The caterpillar, from which this curious sphinx proceeds, is in the highest degree beautiful, and surpasses in size every other European insect of the kind, being sometimes five inches in length: its colour is a bright yellow, the sides marked by a row of seven most elegant broad stripes, of a mixed violet and sky-blue colour; on the last joint of the body is a horn, or process, hanging over the joint in the manner of a tail, having a rough or muricated surface, and a yellow colour. This caterpillar is principally found on the potatoe and the jasmine; it usually changes into a chrysalis in the month of September, retiring for that purpose pretty deep under the surface of the earth; the complete insect emerging in the following summer. This species is generally considered as a very rare insect; and as the caterpillar feeds chiefly by night, concealing itself during the day, it is not often seen. See Plate IV. Entomology, fig. 7.

S. ligustri, or privet hawk-moth, is a large insect, measuring nearly four inches and a half from wing's end to wing's end: the upper wings of a brown colour, most elegantly varied or shaded with deeper and lighter streaks and patches; the under wings and body are of a fine rose colour, barred with transverse black stripes. The caterpillar, which is very large, is smooth, and of a fine green, with seven oblique purple and white stripes along each side; at the extremity of the body, or top of the last joint, is a horn or process pointing backwards. This beautiful caterpillar is often found in the months of July and August feeding on the privet, the lilac, the poplar, and some other trees, and generally changes to a chrysalis in August or September, retiring for that purpose to a considerable depth beneath the surface of the ground, and, after casting its skin, continuing during the whole winter in a dormant state, the sphinx emerging from it in the succeeding June.

S. ocellata is perhaps still more beautiful: it is rather a smaller insect than the preceding, and has the upper wings and body brown; the former finely clouded with different shades, while the lower wings are of a bright rose-colour, each marked with a large ocellated black spot.

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with a blue interior circle and a black centre. This insect proceeds from a green caterpillar, of a rough or shagreen-like surface, marked on each side by seven oblique yellowish-white streaks, and furnished, like the preceding, with a horn at the tail. It is principally found on the willow; retires under ground, in order to undergo its change into the chrysalis state, in the month of August or September; and in the following June appears the complete insect.

SPICA, in botany, a term applied to a particular mode of flowering, in which the flowers are ranged alternately upon both sides of a simple common flower-stalk. The flowers in the spica are seated immediately upon the stalk, without any partial foot-stalk, in which it differs from a racemus, or cluster. A spica is said to be single rowed when the flowers are all turned towards one side; and to be double rowed when they look to both sides, or stand two ways.

SPIDER. See ARANEA.

SPIELMANNIA, in botany, so named in honour of James Reinbold Spielmann, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx five-cleft; corolla bearded at the throat, with a five-cleft almost equal border; drupe with a two-celled, two seeded nut. There is only one species, *viz.* S. Africana, silex leaved Spielmannia, or lantana, a native of the Cape of Good Hope.

SPIGELIA, in botany, so named in memory of Adrian Spigelius, a genus of the Pentandria Monogynia class and order. Natural order of Stellatæ. Gentianæ, Jussieu. Essential character: corolla funnel shaped; capsule twin, two-celled, many seeded. There are two species, *viz.* S. anthelmia, annual worm-grass; and S. marilandica, perennial worm-grass.

SPIKING *up the ordnance*, a sea phrase, used for fastening a quoin with spikes to the deck close to the breech of the carriages of great guns, that they may keep close and firm to the ship's sides, and not get loose when the ship rolls, and by that means endanger the breaking out of a butt head of a blank.

SPILANTHUS, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx almost equal; down two-toothed; receptacle conical, chaffy. There are nine species. This genus is made up chiefly of those species of bidens and verbesina which do not properly belong to those genera; they are natives of the East and West Indies.

SPINA, in botany, a *thorn*, a species of offensive weapon, protruded from the wood of the plant, and which is therefore of a stronger and harder nature than prickles, which are detached portions of the bark. Thorns, which are an expansion of the ligneous body, are compared to the horns of animals, which adhere to the bones of the skull, and are protruded from them.

SPINACIA, in botany, *spinach*, a genus of the Dioecia Pentandria class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: male, calyx five parted; corolla none: female, calyx four-cleft; corolla none: styles four; seed one, within the hardened calyx. There are two species: *viz.* S. oleracea, garden spinach; and S. fera, wild spinach. There are also two varieties.

SPINDLE, in the sea language, is the smallest part of the ship's capstan, which is between the two decks. The spindle of the jeer-capstan has whelps to heave the viol. The axis of the wheel of a watch or clock is also called the spindle. Among miners, the spindle is a piece of wood fastened into either stow blade.

SPINELLE, in mineralogy, a species of the flint genus: its principal colour is red, from which it passes on the one side into blue, and even into green, on the other into yellow and brown. Its colours are mostly deep, and they have always a shade of black. Sometimes it is enveloped in an opaline crust; sometimes it exhibits an opalescent iridescence. It occurs in grains, which, from their aspect, show that they have been rolled, and also crystallized. Its specific gravity is from 3.5 to 3.7. It is unalterable before the blow-pipe without addition; but is fusible with borax: it consists, according to Klaproth, of

Alumina	74.5
Silica	15.5
Magnesia	8.25
Oxide of iron	1.50
Lime	.75
	100.5

Vauquelin gives a somewhat different analysis. It is found in the kingdom of Pegu, and in the island of Ceylon, accompanied with zircon, hyacinth, tourmaline, and ceylanite. It is employed

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as a precious stone, and is of considerable value; but it is not so hightly esteemed as the oriental ruby: from this it is distinguished by being harder, and of a greater specific gravity.

SPINET, or SPINNET, a musical instrument, ranked in the second or third place among harmonious instruments. See MUSICAL *Instruments*.

SPINIFEX, in botany, a genus of the Polygamia Dioecia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: hermaphrodite; calyx glume two-valved, two-flowered; valves parallel to the rachis; corolla two-valved, awnless; stamens three; styles two: male, calyx common with the hermaphrodite; corolla and stamens similar. There is only one species; *viz.* S. squarrosus, a native of the East Indies, China, and Cochin China, on sandy coasts.

SPINNING, the act of reducing silk, flax, hemp, hair, wool, or other matter, into thread. Spinning is either performed on the wheel, or with a distaff and spindle, or with other machines proper for the several kinds of working. Hemp, flax, nettle-thread, and other like vegetable matters, are to be wetted in spinning: silks, wools, &c. are spun dry, at least they do not stand in need of water: there is, however, a way of spinning or reeling silk as it comes off the cases or balls, where hot, or even boiling water is to be used. The vast variety and importance of these branches of our manufactures, which are produced from cotton, wool, and flax, spun into yarn, together with the cheapness of provisions, and the low price of labour, in many foreign countries, which are the rivals of our trade, have occasioned many attempts at home to render spinning more easy, cheap, and expeditious. Mr. Arkwright has carried the invention to a high degree of perfection. He not only contrived methods for spinning cotton, but obtained a patent for making cotton, flax, and wool, into yarn. See MANUFACTURE *of Cotton*.

SPINTHERE, in mineralogy, one of the earthy fossils, of a greenish colour: it occurs crystallized, in irregular, double, four-sided pyramids, which are obliquely truncated. The crystals are small, and the fracture foliated. It melts very easily before the blow-pipe.

SPIO, in natural history, a genus of the Vermes Mollusca class and order: body projecting from a tube, jointed, and furnished with dorsal fibres; peduncles, or feet, rough with bristles, and placed towards the back; feelers two, long, simple; two eyes, oblong. There are two species, *viz.* S. seticornis: feelers thin and striate: is found in the ocean, principally where there is a clayey bottom: it is about three inches long: the tube is composed of agglutinated particles of earth, thin, erect, and thrice as long as the body; from this the animal projects its capillary white feelers in search of food, which consists of small marine worms: body whitish, with a tinge of green, and a red line down the middle of the back; the hind part sea-green; the fore part blackish grey, with transverse white striæ: head pale. The other species is S. filicornis; feelers thick and annulate: it inhabits the seas about Greenland; it is about an inch long, and from its tube projects its feelers in search of Planariæ, and other small marine worms.

SPIRÆA, in botany, a genus of the Icosandria Pentagynia class and order. Natural order of Pomaceæ. Rosaceæ, Jussieu. Essential character: calyx five-cleft; petals five; capsule many-seeded. There are twenty-two species.

SPIRAL, in geometry, a curve line of the circular kind, which, in its progress, recedes from its centre.

A spiral, according to Archimedes, its inventor, is thus generated: if a right line, as AB, (Plate Miscel. XIV. fig. 9.) having one end fixed at B, be equally moved round, so as with the other end A to describe the periphery of a circle; and, at the same time, a point be conceived to move forward equally from B towards A, in the right line BA, so as that the point describes that line, while the line generates the circle: then will the point, with its two motions, describe the curve line B 1, 2, 3, 4, 5, &c. which is called the helix or spiral line; and the plane space contained between the spiral line and the right line BA is called the spiral space.

If also you conceive the point B to move twice as slow as the line A B, so as that it shall get but half way along the line B A, when that line shall have formed the circle; and if then you imagine a new revolution to be made of the line carrying the point, so that they shall end their motion at last together, there will be formed a double spiral line, and the two spiral spaces, as you see in the figure. From the genesis of this curve, the following corollaries may be easily drawn. 1. The lines B 12, B 11, B 10, &c. making equal

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angles with the first and second spiral (as all B 12, B 10, B 8, &c.) are in arithmetical proportion. 2. The lines B 7, B 10, &c. drawn any how to the first spiral, are to one another as the arches of the circle intercepted between B A and those lines. 3. Any lines drawn from B to the second spiral, as B 18, B 22, &c. are to each other as the aforesaid arches, together with the whole periphery added on both sides. 4. The first spiral space is to the first circle as one to 3. And 5. The first spiral line is equal to half the periphery of the first circle; for the radii of the sectors, and consequently the arches, are in a simple arithmetical progression, while the periphery of the circle contains as many arches equal to the greatest; wherefore the periphery to all those arches is to the spiral lines as 2 to 1.

SPIRAL, in architecture and sculpture, implies a curve that ascends, winding about a cone or spire, so as all the points thereof continually approach the axis. It is distinguished from the helix by its winding around a cone, whereas the helix winds in the same manner around a cylinder.

SPIRALS, *proportional*, are such spiral lines as the rhumb lines on the terrestrial globe, which, because they make equal angles with every meridian, must also make equal angles with the meridians in the stereographic projection on the plane of the equator; and therefore will be, as Dr. Halley observes, proportional spirals about the polar point.

SPIRE, in architecture, was used by the ancients for the base of a column, and sometimes for the astragal, or tore. But, among the moderns, it denotes a steeple that continually diminishes as it ascends, whether conically or pyramidally.

SPLACHNUM, in botany, a genus of the Cryptogamia Musci class and order. Generic character: capsule cylindrical; veil and receptacle very large; fringe with eight teeth. Male, a bud on a different plant; circular, terminating.

SPLEEN, See ANATOMY.

SPLENTS, or SPLINTS, in surgery, pieces of wood, used in binding up broken limbs.

SPLICING, in the sea language, is the untwisting the ends of two cables or ropes, and working the several strands into one another by a fidd, so that they become as strong as if they were but one rope.

SPLINTER, a small shiver of wood, or the like. The splinters of fractured bones, if loose, are to be carefully removed, otherwise replaced.

SPODUMENE, in mineralogy, one of the earthy fossils, of a greenish-white colour, passing into apple-green. It occurs in small masses, is shining, and of a pearly lustre. Specific gravity about 3.2. It splits before the blow-pipe into smallish yellowish folia, and at length melts into a greyish-white transparent glass. It is found in the mines of Upton, in Sweden, accompanied with quartz and black mica.

SPONDEE, *spondæus*, in ancient poetry, a foot consisting of two long syllables, as *omnes*.

Some give the appellation spondaic to verses composed wholly of spondees, or at least that end with two spondees; as,

Constitit, atque oculus Phrygia agmina circumspexit.

SPONDIAS, in botany, *hog-plum*, a genus of the Decandria Pentagynia class and order. Natural order of Terebintaceæ, Jussieu. Essential character: calyx five-toothed; corolla five-petalled; drupe with a five-celled nut. There are four species.

SPONDYLUS, in natural history, a genus of the Vermes Testacea class and order: animal a tethys: shell, hard, solid, with unequal valves; one of the valves convex, the other rather flat: hinge with two recurved teeth, separated by a small hollow. There are four species: the shell of the S. gædaropus is slightly eared, and spinous: it inhabits the Mediterranean, Indian, and other seas, and is found in almost infinite varieties as to size, thickness, and colours; sometimes entirely purple, orange, white, or bloom colour; sometimes marked with various streaks, spots, dots, or bands.

SPONGIA, in natural history, *sponge*, a genus of the Vermes Zoophyta class and order: animal fixed, torpid, of various forms, composed either of reticulate fibres, or masses of small spines, interwoven together, and clothed with gelatinous flesh, full of small mouths on its surface, by which it absorbs and rejects water. Between fifty and sixty species have been enumerated. S. officinalis is irregularly formed, porous, tough, lobed, and woolly: It is found in the Archipelago, Mediterranean and Indian seas, adhering to rocks by a broad base: it is often found inclosing small stones, shells, and particles of sand: variety of marine animals pierce and gnaw it into irregular winding cavities, which appear on the outside by

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large holes higher than the rest: its colour varies from a pale to a deep yellow; the internal part, when cut perpendicular, consists of small tubes, composed of reticulate fibres, and ending on the outside in an infinite number of small circular holes, which are the bibulous mouths of the animal, each of which is surrounded by a few erect pointed fibres. This is the common sponge of the shops.

S. ventilabrum, is fan-shaped, regular, soft, with reticulate woody veins, covered with pores like a honeycomb. This species inhabits the Norway and American seas; is about six inches high, and five broad: exactly resembles a small Gorgonia flabellum in its shape and ramifications, except that the pores are angular, and the substance is spongy.

S. cristata, or cock's-comb sponge, is flat, erect, and soft, growing in the shape of cock's combs, with rows of little holes along the tops, which project a little. It abounds on the rocks to the eastward of Hastings, in Sussex, where it may be seen at low-water. It is commonly about three inches long, and two inches high, and of a pale yellowish colour. When put into a glass vessel of sea water, it has been observed to suck in and squirt out the water through little mouths along the tops, giving evident signs of life.

S. tomentosa, or urens, stinging sponge, or crumb of bread sponge, is of many forms, full of pores, very brittle and soft, and interwoven with very minute spines. It is full of small protuberances, with a hole in each, by which it sucks in and throws out the water. It is very common on the British coast; and is frequently seen surrounding fucuses. It is found also on the shores of North America, Africa, and in the East Indies. When newly taken out of the sea, it is of a bright orange colour, and full of gelatinous flesh; but when dry, it becomes whitish, and when broken has the appearance of crumbs of bread. If rubbed on the hand, it will raise blisters; and if dried in an oven, its power of stinging is much increased, especially that variety of it which is found on the sea coast of North America.

S. fluviatilis, river sponge, is green, erect, brittle, and irregularly disposed in numerous branches. It abounds in many parts of Europe, in the fresh rivers of Russia and England, but particularly in the river Thames. It scarcely exhibits any symptoms of life; is of a fishy smell; its pores, or mouths, are sometimes filled with green gelatinous globules.

So early as the days of Aristotle sponges were supposed to possess animal life; the persons employed in collecting them having observed them shrink when torn from the rocks, thus exhibiting symptoms of sensation. The same opinion prevailed in the time of Pliny. But no attention was paid to this subject, till Count Marsigli examined them, and declared them vegetables. Dr. Peysonell, in a paper which he sent to the Royal Society in the year 1752, and in a second in 1757, affirmed they were not vegetables, but the production of animals, and has accordingly described the animals; and the process which they performed in making the sponges. Mr. Ellis, in the year 1762, was at great pains to discover these animals. For this purpose he dissected the spongia urens, and was surprised to find a great number of small worms, of the genus nereis, or sea scolopendra, which had pierced their way through the soft substance of the sponge in quest of a safe retreat. That this was really the case, he was fully assured of, by inspecting a number of specimens of the same sort of sponge, just fresh from the sea. He put them into a glass filled with sea water: and then, instead of seeing any of the little animals which Dr. Peysonell described, he observed the papillæ, or small holes with which the papillæ are surrounded, contract and dilate themselves. He examined another variety of the same species of sponge, and plainly perceived the small tubes inspire and expire the water. He therefore concluded, that the sponge is an animal, and that the ends or openings of the branched tubes, are the mouths by which it receives its nourishment, and discharges its excrements.

SPOON-*bill*. See Platea.

SPOONING, in the sea language, is said of a ship, which, being under sail in a storm at sea, is unable to bear it, and consequently forced to put right before the wind.

SPORTING. Although we have not omitted to notice what generally appertains to the winged, finny, or quadruped parts of nature, it appeared to us better to collect the whole of the matter relating to sporting, in general, under one head; thereby to preclude the necessity for reverting to other volumes for such information as might be sought. The reader will, however, remark, that we have, under the article Angling, furnished an ample detail of that diversion: therefore we shall proceed to the discussion of what relates to Fowling. The

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first item presenting itself to our consideration is the gun; which ought always to be suited to the occasion. For ordinary field excurions, that is to say, when questing for pheasants, or partridges, the piece ought to be conveniently light, and of rather a small bore; the barrel from two feet four to two feet six, or perhaps eight inches in length. Chambered guns undoubtedly strike hardest, and in most instances will be found to scatter least. Hence a good marksman will prefer such; but taking care to allow full thirty yards distance to the bird, unless in cases of emergency, before the trigger is drawn. When this precaution is neglected, the chance of missing is greater; while, on the other hand, such birds as may be hit are absolutely spoiled by the column of shot which brings them down. The gun requisite for cocking, that is, for wood-cock shooting, is of a very light construction, and very short; because the birds generally rise well within shot, and that the branches of trees, &c. may be less in the way of the gun's motion while taking aim. We have seen some guns made for this branch of shooting that have been little heavier than a large horse-pistol. With regard to such birds as are found on plains, or are aquatics, guns of a larger calibre, and more strongly fortified, so as to resist a large charge of powder without recoiling severely, are indispensably necessary. The selection of a gun, must, after all, depend on various circumstances: for instance, a powerful man, in the prime of life, and of a large stature, would be no ways incommoded by such a one, as would prove highly distressing to an elderly person, of a weak frame, and of a diminutive size. Again, we necessarily make a distinction according to the nature of the sport: hence, when shooting in a punt, or when laying wait for water-fowl, a heavy gun may be used. In truth, without a very strong charge, some of the more shy, or more full feathered, birds are not easily brought down. Some experienced persons find that with a stout barrel, weighing from ten to fourteen pounds, they can bear the recoil of even two drachms of powder; which in an ordinary piece would produce, at least, an highly unpleasant recoil, if not some damage to either the piece or the sportsman. Every barrel ought to be chambered; because the piece is thereby strengthened, and the force, or impetus, of the shot considerably increased. With respect to the kind of chamber, a variety of opinions exist; for the most part purely theoretical, and in support of some favourite hypothesis, started, by way of novelty, by some maker anxious to obtain celebrity. After mature consideration, we are rather disposed to accord with a number of old sportsmen in commending the plain cylindrical chamber, made in the butt screw, or by a very small screw stump added to the butt of the piece: the latter being preferable in respect to security against lodging fire in the worm of the screw; but rather more expensive.

The lock of a gun is a most important object. It cannot well be too small and compact, provided space be allowed for the free movement of the several parts. We all know that the lock of a pistol will answer its purpose as well as that of a musket. The great consideration is, that friction should be avoided by every possible means, which is best effected by the most simple movements, and by keeping them clear from the plates. Every part subject to the action of another should be well steeled and hardened; and, where practicable, friction rollers should be employed. The pan, above all things, ought to shut very close, and to spring up in a smart manner, when struck by the flint. The trigger should not be subject to action at half-cock; but at full-cock ought to draw with little resistance: at least, it should not require such force as might derange the aim, or delay the discharge.

Such guns as have double barrels are commonly provided with a trigger for each lock; though some are made with but one trigger. In the former case, either barrel may be discharged at pleasure, which is not always the case in the latter mode of construction; which, though apparently more simple, is by no means so convenient. The alleged reason of having but one is, that the interior is simplified, while the sportsman is less bewildered in regard to the choice of triggers, and in the application of the finger thereto; but we conceive, that no cool or expert sportsman is ever at a loss in those particulars.

We now come to speak of the sizes of shot in ordinary use, as they are appropriated to various kinds and sizes of birds: observing, that many old sportsmen and game-keepers, consider it advantageous to mix No. 4, 5, 6, and 7, in nearly equal quantities. This, however, does not seem to be warranted. The application of particular sizes to corresponding purposes appears to us

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more proper; nor can we reject that which rests on the solid basis of reason, in favour of a system but partially supported, even in words, and without a sufficient course of experiment under the eye of impartiality. We have, indeed, the assertions of various gentlemen, of the most candid dispositions, and versed in those experimental tests requisite to sanction a practice, whereby it should appear that no mixture should ever take place; but that where large, shy game is sought (such as wild geese, bustards, &c.) No. 1 should be used; or, in default of that, No. 2: that where wild ducks, and other hard-feathered birds are in view, No. 3 or 4 should be used; that for hares, pheasants, and partridges, No. 4 and 5 ought to be employed; that for woodcocks, No. 6 and 7 suit well; while for shipes and quails, No. 7 and 8 answer admirably. As for ortolans, larks, &c. No. 9 and 10 should be used, where the birds are not very shy; otherwise No. 8.

From this it will be seen, that No. 4, 5, 6, and 7, certainly constitute the general expenditure of the regular sportsman: but we cannot, from that, deduce, that they ought to be mixed. However much we may differ, in the above point, from the Rev. W. B. Daniel, author of the celebrated "Rural Sports," such is the opinion we entertain of that work, that we shall present our readers with the following passage, extracted from his second volume. He gives the following table:

	Grains.
"One ounce of common shot, No. 4, contains	166
Charge for double gun	317
One ounce of patent shot, No. 4, contains	202
Charge for double gun	375

The difference of charge, between the patent and the common shot, is therefore 58 grains in the ounce.

One ounce of No. 5, common shot, contains	230
Charge for ditto	437
One ounce of patent ditto	271
Charge for ditto	512

Difference 75 grains.

One ounce of No. 6, common shot, contains	300
Charge for ditto	554
One ounce of patent ditto	327
Charge for ditto	630

Difference 76 grains,

	Grains.
One ounce of No. 7, common shot, contains	363
Charge for ditto	708
One ounce of patent ditto	388
Charge of ditto	757

Difference 49 grains.

MIXED SHOT.

One ounce of No. 4, 5, 6, common shot, contains	232
Charge for ditto	434
One ounce of patent ditto, No. 4, 5, 6	263
Charge for ditto	493

Difference 59 grains.

One ounce of No. 5, 6, and 7, common shot, contains	297
Charge for ditto	582
One ounce of patent, No. 5, 6, 7	330
Charge for ditto	599

Difference 17 grains."

Our readers connot fail to perceive, that the word "charge" is, in the above case, purely arbitrary: we necessarily conclude that Mr. Daniel found such answer well for the double barrel gun which he used: which might be of a large, or of a small bore. Taking the average, we compute his charges to weigh about 9 or 10 to the pound; and this we may, perhaps, find to be tolerably correct, as a standard on common occasions; since it is found, in general, that a bag of shot, weighing a quarter, *i. e.* 28 pounds, will make about 260 charges.

Mr. Daniel continues as follows:

"The smallest shot above mentioned, (*i. e.* No. 7.) will kill at forty yards; the velocity of a charge of No. 7 being equal to one of No. 3, at that distance; and since small shot fly thicker than large in proportion to size, and as there are many parts about the body of a bird, wherein a pellet of No. 7 will affect its vitality equal to a pellet of No. 2, the chances for using the former are multiplied in the marksman's favour; for it is the number and not the magnitude of the particles, that kills on the spot. If sportsmen would be persuaded to use No. 5 and 6 in grouse and patridge, and No. 7 in woodcock-shooting, instead of No. 3 and 4, and No. 4 and 5 for black game and pheasants, instead of No. 2 and 3, they would bring home one-third more game, and not destroy one bird more than usual. They who prefer large shot, and accustom themselves to fire at great distances, leave nearly as many languishing in the

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field, as immediately fall; whereas those that use small shot, and shoot fair, fill their bag, with little spoil or waste, beyond what they take with them from the field."

We derive much satisfaction from the support of so respectable an authority, and from the assurance of another veteran in ornithologic devastation, who assures us, that for upwards of twenty years he never used any shot for field sport above the size of No. 6, with which he has killed bustards and deer; the same authority further states, that for the ordinary birds of small game, such as snipes and quail, No. 8 was always found perfectly adequate. For geese, and in general for ducks, it was his constant practice to load with No. 2 or 3, according to the expanse of water. We are likewise indebted to the same authority for a kind of standard, by which sportsmen in general may be guided with propriety; which serves, at the same time, to supply the deficiency prevailing in all publications on this subject.

"Many persons are unable to estimate the proper charges of powder and shot for their respective pieces: it is true, some authors tell us to be guided by the weight of the ball; but it often happens, that a ball is not at hand; and, when obtained, unless it fits exactly, and is perfectly spherical, will not determine the true dimensions of the bore. I have always found that, with the best powder, a charge equal to a diameter and a half of the bore was the best, that is, the most efficient quantity; that it impelled an equal quantity of shot with great force; and that without causing too great a recoil. Thus, if the bore were six-eighths of an inch, the load of powder, poured loosely into the piece, should raise the ramrod nine-eighths of an inch; or one inch and one-eighth. The wadding should be of thick leather or felt (*i. e.* old hat) cut out with a machine; that should be rammed down firmly, but not so as to bruise the grains of powder. Then put in the same measure of shot as you did of powder, and ram it down rather moderately, after covering with a second wadding as above. Observe, that shot will spread more or less in proportion to the force with which it is rammed down; the more it is rammed, the less it will diverge. The above mode of charging will cause the charge in a piece of three quarters of an inch bore to occupy a depth of full two inches and a half in depth. Some, who have a great predilection for large charges, may smile at the above quantity, which has, however, answered admirably with me, and will be found, under fair and repeated experiments, to be the most killing charge than can be used. But I must remark, that, owing to some fault in the construction, and especially if the vent be placed at all beyond the bottom of the barrel, some guns will recoil severely, even with the above moderate charge. When such is the case, I should recommend that the piece be chambered."

The foregoing perpicuous mode of charging appears so reasonable, and is founded on so regular a computation, that we feel a confidence in urging all sportsmen to give it a fair trial; it is obviously moderate; therefore, may be considered as devoid of danger. Upon that principle we could expatiate, at great length, regarding the highly culpable practice of carrying a piece full-cocked; also of letting it swing in such a direction as might cause the charge, in case of accident, to wound any person in the field. The muzzle ought always to be carried above the shoulder; and, in general, it ought to be the endeavour of every sportsman to avoid every liability to endanger either himself, or any other person. However inconvenient stop locks may prove on some occasions, they nevertheless have the great recommendation of being on the safe side of the question: when a gun is put by in a situation accessible to other persons, even when unloaded, it ought to have the lock stopped, to prevent its being injured; but when a piece is loaded, which should never be the case, except under very pressing circumstances, due care ought to be taken to prevent its being in the hands of children, or of any but those for whose use it may be intended.

Having said thus much in regard to the construction or kinds of guns proper for shooting in general, we shall proceed to state a few particulars relating to the various kinds of game generally sought, and to give the sportsman as much insight as our limits may allow, regarding the laws in force on the subject of shooting, &c.

The *Bustard* is the largest of our feathered game, the male sometimes weighing nearly thirty pounds, being in length (from beak to toe) nearly four feet, and expanding its wings so as to measure full nine feet between their tips. Some consider it to be gallinaceous, while others class it with the ostrich and cassowary. The

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bill is strong and somewhat convex; the eyes red; head and neck ash-coloured, and on each side of the lower beak is a tuft of feathers from five to nine inches in length; in some countries of a beautiful jet black, but with us of a white or dun colour. The back is barred transversely with black and bright rust colour; the greater quill-feathers are brown, the belly white, the tail has twenty feathers, the middle ones barred with black; the legs are long, naked above the knees; it has no hind-toe (which is a peculiarity whereby this genus is distinguished, for there are innumerable varieties in different parts of the world) but has a callous process, serving as a heel. The female rarely exceeds twelve pounds in weight, and is not so strikingly marked as the male, and has no tufts under the bill; her colour is more dull, and she has not the reservoir, or water pouch, found within every male, and which is capable of containing from four to seven pints of water. This enables the bustard to remain for a long time on those immense plains, remote from water, where it is often found, and where the female lays her eggs, which are of a pale olive brown, sprinkled with dark spots; her nest is very soon made, being nothing more than a shallow hollow, scraped in some dry place, especially in a turnip field, or in some dry stubble, or grass, whence she can see whatever approaches. Her own colour so much resembles the soil, that unless scented by dogs, she is often put up by persons, who almost tread on her before she rises.

Bustards were formerly numerous in England, but now are only found in the south and east parts, particularly on the large downs of Yorkshire, and of Wiltshire and Dorsetshire; they are supposed to be extinct in Scotland. They very rarely wander more than thirty miles from their native haunts, making very short flights, running very rapidly, and rising from the ground with considerable difficulty. Hence they have been frequently caught by grey-hounds, after chases affording considerable diversion. It is evident, that for so heavy a bird, large shot must be necessary; especially when found on a plain, where it is extremely shy. Some have, however, been brought down with No. 6; but in such cases they have risen within a moderate distance. In aiming at the bustard with large shot, endeavour to strike under the wing; but if with any thing less than No. 2, you cannot do better than level just before his beak; so as to hit the head. This bird is by some called the floriken; in the east it is called the cherruss.

The *Pheasant*, though not a native of England, nor indeed of Europe, for it was first brought from the banks of the Phasis in Asia Minor, has multiplied so extensively among us, as to form a very considerable object among the sporting world. The cocks sometimes weigh nearly four pounds; though, in general, not more than three; the hen is usually from eight to twelve ounces lighter. This bird is too well known to require description in respect to colour or figure. The wings of a pheasant are extremely weak; hence it can rarely fly half a mile. To this it is attributed, that none are found on the new continent; though they are now very numerous throughout Europe, and in some parts of Africa, as well as in Asia. There are many varieties, such as the argus, of which the wings are all over dotted as with eyes; the golden, which is of a beautiful lustre green, marked with gold coloured specks of the most vivid appearance; the black, which is only found in India, where it is called the Moco, and is erroneously considered as appertaining to the crow-tribe.

The pheasant does not easily resign its wild habits; when it does, it seems to languish; it lays but few eggs, and is indifferent, or indeed at a loss, regarding its young; which are usually hatched and reared by a common hen, on that account. When allowed to ramble, they multiply as quick as the means of subsistence may afford, and appear to thrive during even our most rigorous winters. They are extremely fond of ants; without which, it is asserted by many, they will neither breed, nor remain where bred. In coppices abounding with haws, hips, and many other kinds of berries, the pheasant takes great delight; they also fatten a little upon acorns. They begin crowing about the middle of March, when they will sometimes come into the farmyards and tread the common hens, whence many assert the finest game fowls are produced; for the pheasant is remarkable for his spirit. One cock serves seven or eight hens. They are particularly fond of clover, especially when it stands for seed. In that they will, if undisturbed, make their nests; hence so many young and eggs are destroyed by the scythe.

In pheasant shooting, most old sportsmen confine their aim to the cock birds, unless the game is extremely abundant;

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when it is often necesssary to thin them, on account of the prodigious damage they do among ripening corn. When the corn is cut, they will frequent the stubble, in search of the stray grains, until alarmed by the researches of sportsmen; at first they take to the hedge-rows, where they often lay extremely close, or wind in among the briars, so as to puzzle the spaniels, and to rise in a position adverse to the sportsman. After being several times put up, they take refuge in heavy woods, in which it is extremely difficult to make them take wing; there they run under the low bushes, and generally gain much upon the dogs, unless followed up with great spirit and activity. Aim at the head or wing, allowing a moderate advance for the bird's flight, which is, at first, very rapid, but soon becomes languid, and is at all times very fluttering and noisy.

Sportsmen are sometimes deceived in regard to the sex of the bird they fire at; for a peculiarity obtains among pheasants which is perhaps little known; namely, that after a certain age the hen becomes barren, moults, and assumes the plumage of the cock. In this state she is subject to the jealousy of all the males, and has an unnatural bent towards the destruction of whatever eggs, of her own species, she can find.

Pheasant shooting commences on the first of October, and requires very well trained spaniels. Such as are strong in the chest and loins, with very short legs, are keen, obedient, and courageous, should be selected. Unless these qualities exist, the sportsman will meet with great mortification; his dogs will put up the birds at a great distance, and, after having fatigued themselves, will hunt without spirit or discrimination. They will drive the pheasants up among the low boughs in the woods, and puzzle to no purpose. Spaniels that have a taint, however remote, of the hound, will be babblers, unsteady, and quit birds for hares. If good, you cannot have too many spaniels for pheasant shooting: but, if bad, every additional dog will prove an additional tormentor.

Mr. Daniel justly observes, "there are no fixed rules for beating coverts; this, however, ought to be a standing regulation, never to beat in a slovenly manner; a nide of pheasants are sometimes collected in a very small space, and in the middle of the day conceal themselves very close. In the early part of the season, pheasants prefer grassy, brambly, two and three year old slops; and it is lost labour to try higher growths: as the season advances, they will lie in clearer bottoms, especially among pits of water, which are sometimes found in woods. In winter skirting the edges, and afterwards, by degrees, sinking deeper into the coverts, is, perhaps, where the game is not very plentiful, as good a mode as any. The haunt of the game that have been feeding in the adjoining fields will thus probably be hit off; and it may, at least, serve to show whether there is game in the covert. If any of the spaniels are wide rangers, after traversing the wood well, always make a concluding circuit round the edge of it: depend upon getting shots, by this means, at those birds which may have ran or flown from the interior parts."

The *Partridge* is the most common species of field game in England. We have several varieties of this delicious bird, but those we call partridges are either grey or red; the latter is the biggest, and often perches upon trees: not being a native of our climate, but first introduced from the south of Spain, it is not very common, and is reared with some difficulty. The grey always keep on the ground, and form by far the greater part of the sportsman's success. The partridge, of whatever species, rarely remains long in the forest; but has its haunts under thick grown hedges, especially near to stubbles, wherein it feeds with its young so soon as the gleaners have performed their task. The partridge hatches a full month before the pheasant; therefore the former may be killed on the first of September. The propensity of the partridge to frequent open fields subjects it to great danger, both from regular sportsmen and from poachers; the latter avail themselves of the alacrity with which this bird answers to the call, and by aid of a well broke setting dog, perhaps of no blood, but completely obedient, and keen after game, it is covered with the net, or led into a labyrinth of springes. The male bird generally weighs nearly a pound, the female ordinary about two or three ounces less. They pair about the middle or end of February; there are always more cock than hen chicks: this produces great struggle for possession of mates, in which many are killed. The Duke of Kingston used to have his covies netted so soon as the birds began to pair, and thinned the number of cocks, and thereby had regular broods, which never happens when the hens are followed by two or more cocks; as she then drops her eggs in different places, and cannot, of course, hatch them

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in any numbers. The hens lay on the ground, among a few bents and leaves scraped together, usually within some hollow made by the tread of a horse, or by the removal of some large stone or clod. Partridges are very amorous and prolific: they ordinarily lay from sixteen to twenty eggs, and often may be seen leading their young in covies of seven or eight brace. In 1793, on a farm occupied by Mr. Pratt, near Terling, in Essex, a nest was found in a fallow, containing thirty-three eggs; of these twenty-three were hatched, and the birds fledged; four more had nine birds in them; the eggs were piled in a very curious manner by the hen, which covered them all. The above instance of fecundity, though rare, is not singular; for in June 1801, at the seat of Mr. Clark, Walton Place, Northumberland, a nest was found in a plantation, containing thirty-three eggs; and in 1798, one was found in a wheat-field, in Somersetshire, with twenty-eight eggs. In the year 1788, a partridge was found sitting in the heart of an oak pollard many feet from the ground; although a stile was fixed into the tree, and persons were perpetually passing by. She hatched sixteen eggs, and assisted her chicks to scramble down among the twigs, until they were all in safety on the grass.

While the chicks are young and unable to fly, the old birds attend to them very assiduously; at the least alarm they all shelter under the hen's wings, or perhaps under those of the cock. When a dog, &c. breaks in, the cock pretends to be in a state of debility, and separates from the hen, which leads the brood away; the dog is thus led astray. Partridges will also fly at a kite that hovers over their young, in defence of which they are extremely daring and indefatigable. These birds often pair with barn-door fowls; but are by no means prone to domestication. It is probably owing to the intermixture, that covies have been seen pied, party-coloured, or white.

In shooting partridges, pointers and setters are usually employed: they should be thoroughly staunch, and perfectly under command. The best pointers are of a tall stature, rather light than heavy in the limbs, with small heads, deep chests, and lank about the abdomen. The more white about them, the better they will be distinguished, especially towards the close of day. All dogs that stand, or set, ought to quarter their ground well, and should naturally turn to windward; so as neither to blink nor to run up the birds. Though setters are much used by poachers, yet many gentlemen prefer them to pointers: but they answer for low coverts only, such as clover and stubbles. The poachers work by night, and prefer open countries to such as are enclosed; especially when they use the tunnel-net. To prevent them from catching birds with that destructive machine, a few young partridges should be got early in the season; these, having their bearing claws cut off, cannot run, but always spring, and induce the whole covey to rise. To obviate the ordinary mode of netting birds at night, the stubbles should be bushed; that is, a number of strips of eglantine, dog-rose, or even large thistles, should be laid about in the fields, that the net may be intercepted, and the birds be alarmed.

With regard to the variety of partridges, it would be almost endless to describe them; in some countries they are of a fine black on the breast, where each feather bears a white spot about the size of a pea; the rest of the body being strongly marked with game-feathers. The red-legged partridge is a native of hot climates; it is a beautiful bird, grows very large, and is peculiarly marked with yellow near the eyes, while the breast bears a large dark coloured crescent. Whatever is of a red or glowing colour, attracts these birds greatly; hence they are very keen in swallowing red hot cinders, &c. which, however, soon kill them. This bird is possessed of great speed, and after running for some distance, generally into a covert, will crouch, and allow the dogs to be on the point of seizing, before he will take wing. There are very few of this breed in England; what there are seem to be purely accidental. When wounded, they go to ground in rabbit burrows, &c.

The *Black-grouse*, which is a species of partridge, is found chiefly on extensive woods in the northern parts of Britain: there it is found in immense abundance. Some are also seen in Hampshire; it is peculiarly attached to woody and mountainous situations; especially where the hether grows large, and where juniper bushes abound. The black-grouse perch on trees; they never pair; but when the cocks crow, and clap their wings, the hens fly to them from all quarters. The male weighs full two pounds, in general; the females rather less. They live under the snow during great part of winter; but always take the precaution of eating their fill of birch-catkins before they shelter there. Cherries and peas are deleterious to this bird.

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The *Red-grouse, Moor-cock,* or *Red-game.* This bird lives chiefly on the extensive moors in North Britain, and in the northern parts of England; also in some of the Welsh counties. It is supposed to be a native of Britain, and, indeed, to be peculiar to our islands. The male usually weighs about eighteen ounces; the female about fourteen. They pair in the spring, and the broods flock together during winter; being then remarkably vigilant and shy. They usually resort to the summits of hills covered with hether, juniper, bilberry, &c. It is necessary to draw them so soon as killed; else they speedily become tainted. Setters are better than pointers for following red-grouse, on account of their long hair, which protects them from the action of the coverts; but, to enable their acting with vigour, they must often be supplied with water; which, on many moors, will not be readily found. This sport commences on the 12th of August. In 1801, a gentleman in Invernesshire shot fifty-two braces of moor-game in one day, all single, and on the wing.

The *White-grouse, White-game,* or *Ptarmagan,* is about the same size as the red-grouse; but its plumage is of a pale brown, or ash colour, mottled with dusky spots and minute bars; the head and neck have brood-bars of black, rust colour, and white; the wings are white, as is the belly. The males are beautifully plumed. In winter the ptarmagan is nearly white; they are feathered to the very claws, and have strong hairs growing upon their soles. This bird seems to delight in a cold temperature; always following the snow, (even to the summits of the Grampians,) in which it burrows; it carefully avoids the solar rays. The Greenlanders catch them by dropping loops over their necks, as they sit at the mouths of their burrows, or on stones of their own colour, which they carefully select to roost upon during bleak, dull weather. In Nova Scotia, they are called "birch-patridges; in that quarter, their feathers grow double during the cold months.

The *Quail,* is but little known in England: it may be considered as a small kind of partridge; but it is a bird of passage. There are supposed to be at least two hundred varieties; though we rarely see more than two kinds; *viz.* the brown and the brindled; the latter are, however, extremely scarce. Quails, in our climate, are, in their habits, pretty similar to partridges; but, where they abound, may be seen in bevies, consisting of more than a hundred birds. They are easily domesticated, but for a while only: at the period of migration they invariable disappear; it is said they sometimes return to their former homes. They sleep chiefly during the day, and at night ramble to any place where corn is ripe, or has been cut: being extremely vigilant, and running very fast, it is not easy to put them up. They are peculiarly litigious, and rarely desist until disabled. They will not visit any country where herbage is scarce, or deficient in verdure. They make no nest, but scrape together any rubbish, or even sit in small hollows, without any preparation whatever. The young are very hardy, and, in a week, shift for themselves: usually about ten eggs are found in a nest. As quails take very short flights, and those generally straight, they are excellent practice for the young sportsman: very small shot will kill them.

Corn-crakes, Land-rails, or *Daker-hens,* are always found among corn, grass, broom, or furze: they migrate before winter. The peculiar note of this bird subjects it to immediate discovery; the repeated sound of *crek, crek, crek,* (somewhat similar to springing the edges of a fine comb,) from the thickest part of our meadows, is sure to announce its arrival; generally about the middle of May. It lays about fifteen or twenty eggs; the young birds are covered with a black down, and are very active. Corn-crakes are of a strong scent, and cause dogs to remain for a long time in search; their unwillingness to rise occasions many to be caught by hand; they will not fly until absolutely compelled, and then very heavily, with pendent legs, and to a short distance, but they run very fast. When flitted, they usually perch in a hedge. They mix much with quails, and, like them, weigh from six to eight ounces.

Ruffs and *Reeves* are so diversified in colour, that scarcely two are ever found of the same appearance. The former are the males, and may be known by the ruffs about their throats: they are generally more numerous than the reeves, which are the females. The ruff grows large, but is very light; rarely reaching beyond seven ounces; though extending about two feet between the tips of the wings. These birds are found early in the spring, in the fens of Lincolnshire, and other low countries, but retire, no one knows whither, about Michaelmas.

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The reeves lay four white eggs, marked with rusty spots.

Plovers are of various kinds, but the sportsman pursues only the golden, the grey, and the peewhit, or lapwing. They generally weigh from seven to nine ounces, and visit us only from October to March: and then in no great numbers. Look for them in ploughed fields. Few are shot, but many are netted in green corn-fields, near to water, to which they always resort after a meal, to wash their beaks: their flesh is peculiarly delicate, and the eggs are sold by the London poulterers at the enormous price of four shillings per dozen.

The *Woodcock* is a bird of passage, arriving among us about Michaelmas, and retiring about March: they fly only by night. In the moonlights of November and December, they may be heard passing from about ten till four; they are, however, entirely guided by the wind: they are invariably preceded by the redwing, and followed by the Royston crow. In the spring, when the wind is easterly, the woodcocks assemble on our eastern coasts, linger among the furze, waiting for a westerly change, and may then be killed in great numbers. They rarely stay long in a place, but proceed from one spring-head to another, thrusting their long beaks into the slime, and sucking the worms by which they are nourished. They are particularly fond of such rills as lie within coppices and heavy woods: in such they take very short flights when roused, and will dog among the boughs in a surprising manner. It requires an excellent brace of spaniels, short rangers, and extremely vigorous, for this branch of shooting: great numbers are caught in springes, set on the borders of lakes, &c. Woodcocks generally weigh from twelve to fourteen ounces; but those that arrive early in the season are the largest. When a woodcock rises, he invariably quits his trail, so that nothing is ever found in the intestine. It should be remarked, that some persons seek for woodcocks with pointers, to whose necks small bells are suspended, to rouse the birds, which sometimes are either unable, or averse, to move; but we cannot think such a practice by any means likely to succeed. A person who marks well is a great aid in following this diversion.

The *Snipe* is divided into three classes; the common, the jack, and the great. They all frequent our marshes in the winter season, and are sometimes very numerous: some years since the Duke of Marlborough's game-keeper killed twenty-two snipes at one shot. The several kinds weigh from two to seven ounces; but the great snipe is solitary, and has a beautifully coloured wing: whence it is by many called the "painted snipe." During very cold weather, the snipes are apt to be on the wing; but in the middle of the day, especially when the sun is bright, will lay so as even to be trod upon rather than flit. These birds frequent marshes, and are to be found on the banks of weedy, foul ditches, particularly where the soil is fat, and worms abound.

All the varieties of water-fowl, such as *Geese* of various descriptions, *Ducks* of ditto, *Widgeons*, *Teal*, *Divers*, *Pentails*, *Pochards*, &c. frequent our marshes chiefly from October to February, and in general must be pursued in boats. To be equipped for this sport it is essentially requisite to be well clothed; flannel shirt and drawers, with additional exterior and interior garments, will be found indispensable when polling about the marshes, or when stationed in a punt on the borders of the oozes. Water-proof boots are necessary, as are woollen gambadoes drawing up to the middle of the thigh at least. A cap made of skin must be worn, as the fowls will not approach persons wearing hats, of which they seem to entertain a peculiar dread. It is necessary, when firing at them while on the wing, to aim well before them, it being ascertained that they fly at the rate of ninety miles within the hour! During sharp frosts the sportsman may, early in the morning, find excellent diversion where the brooks are only partially frozen: wherever there is a warm spring, there will he find fowls, provided the spot be at all sequestered, or is not overlooked. Immense numbers of water-fowls are caught in decoys, by means of some of their own species trained to deception: they lead them into narrow passages, netted in a secure manner, near which a man is completely hidden, but who, showing himself suddenly, causes the deluded followers to remain in captivity, while the decoy birds all retreat, and escape the fatal issue.

We shall close what relates to the feathered game with the following glossary of technical terms; many are now obsolete, but as they may afford the means of arriving at the meaning of old authors, we give them a place.

A sege of herons, and of bitterns: an herd of swans, of cranes, and of curlews: a dropping of shelldrakes; a

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spring of teals; a covert of coots; a gaggle of geese; a badelynge of ducks; a sord, or sute, of mallards; a muster of peacocks; a nye of pheasants; a covey of partridges; a bevy of quails; a congregation of plovers; a flight of doves; a dule of turkeys; a walk of snipes; a fall of woodcocks; a brood of hens; a building of rooks; a murmurration of starlings; an exaltation of larks; a flight of swallows; a host of sparrows; a watch of nightingales; and a charm of gold-finches.

Some of the above are no doubt very applicable; but, in general, they are rather quaint than appropriate. The language of fowlers, like that of the turf, abounds with cant, on the exact application of which many pride themselves greatly.

Coursing is generally confined to the pursuit of hares, in which great amusement is afforded to those who are not sufficiently active to join in fox-hunting. Formerly deer and foxes were coursed, but at this date we have no instances of such chases, except in the Highlands of Scotland, and in some parts of Ireland, where many braces of greyhounds are occasionally posted in various directions, as relays to such as may first be slipped after the roe-buck. The laws of coursing were established by the Duke of Norfolk, in Queen Elizabeth's reign, and were agreed to by the nobility, who then followed the diversion: they have been held authentic ever since, and are as follow.

1. The feuterer, or person that lets loose the dogs, was to receive those into his leash that were matched to run together; with these he was to follow the hare-finder, until he should come to the form; no person else being allowed to be on either side, or less than forty yards in the rear of the dogs. 2. A hare was not to be coursed with more than a brace of greyhounds. 3. The hare-finder was to give the hare three "Soho's," before he put her from her form, that the attention of the dogs might be roused. 4. The hare was to have twelve score yards law before the dogs were loosed; unless the proximity of any cover should render such indulgence a prejudice to the chase. 5. The dog that gave the first turn during the course, if there was neither cote, slip, nor wrench, was the winner: a cote is where a greyhound goes endwise by his fellow, and gives the hare a turn. 6. A cote was reckoned as two turns, and two trippings or jerkings made a cote: if the hare did not turn quite about, she made only a wrench; two of which stood for a turn. 7. If no cotes were made, but that one served the other at turning, then he that gave the hare most turns was the winner; but if the turns were equal, the dog that bore the hare won. 8. If one dog turned, and the other bore the hare, the latter won. 9. A go by, or bearing the hare, was equivalent to two turns. 10. If neither dog turned the hare, he that last led to cover won. 11. If one dog turned the hare, served, and turned her again, it was as much as a cote; for a cote was equal to two turns. 12. If all the course was equal, the dog that bore the hare won. 13. If the hare was not borne, the course was adjudged dead. 14. If a dog fell in coursing, and yet performed his part, he might challenge a turn more than he gave. 15. If a dog turned the hare, served himself, and gave divers cotes, and yet, in the end, stood still in the field; the other dog, if he ran the hare to cover, though he gave no turn, was adjudged the winner. In fact, no dog that gave up could win. 16. If by any accident a dog was rode over in his course, or improperly baulked, the course was void, and he who did the mischief was to make due reparation. 17. If a dog gave the first and last turn, and there was no other advantage, or reckoning, between them, he that gave the odd turn won. (Here, we beg leave to observe, is an opening for much misconception). 18. He that came in first at the death, took up the hare, saved her from being torn, cherished the dogs, and cleared their mouths from the wool, was adjudged to have the hare, as the reward of his spirit and assiduity. 19. The judges of the course were to decide all points before they quitted the field. 20. No person could claim any prize or privilege, but under sanction of the judges of the field.

These are certainly very reasonable regulations, and are applicable to all the modern forms of coursing. But the mode now in use is far more simple. A number of horsemen form a line, at about three or four yards asunder, and having a brace of dogs loose at the heels of their owner, or divided in the line, the cavalcade beat the covers, which should be very low, such as hether, or grass, or fallow lands, and all look out sharp for hares sitting. When a hare is seen, the call "Soho" gives notice to the whole party, which then file off, so as to give the hare that offset

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which may appear most favourable to the sport. The dogs are kept back, until the hare is roused from her form, and has some law, when a horseman gallops after her, calling "Hilloo," "Hilloo," so as to lay the dogs in; after which the whole party refrain from crossing her path, and in general ride at some distance behind, so as to avoid checking the course: but in case the dogs should lose the hare among any high grass, &c. one or more horsemen follow her, and again cheer the dogs, until they have her again in view.

Some most extraordinary courses have been made: in 1800 a brace of greyhounds ran a hare for twelve minutes, during which she was often turned, and died before the dogs, at four miles from the spot whence she started. Greyhounds have run with such violence against each other in coursing, that both have been killed on the spot. The finest coursing is in Yorkshire and Wiltshire, in both which counties remarkably fine grey hounds are bred. The following old saying is, perhaps, as good a description as can be given, in few words, of the principal points in a well formed greyhound.

"Head like snake,
Neck like drake,
Back like beam, (*i. e.* cambered, or arched.)
Side like bream (*i. e.* deep chested, and finely keeled.)
Tail like rat,
Foot like cat."

The best age to enter a dog is about a year; some enter them when only ten months old; but one or two severe courses generally ruin them: in truth, coursing is too laborious for any dog not fully formed, and possessed of a good constitution. Greyhounds are very delicate while young; and are perhaps, of all dogs, most subject to distemper. They are not full grown until two years old. The bitches generally have most speed, and the dogs most strength. To give them good wind, biscuit soaked in good broth is their best diet; but no food should be given for four hours, at least, before a dog is to run.

Hare-hunting generally commences so soon as all the crops are fairly off the ground, and that the leverets, or young hares, have acquired strength enough to stand before the hounds. The dogs mostly employed in this sport are the north country beagle, which is nimble and vigorous, pursues a hare with impetuosity, gives her no time to double, and, if the scent lies high, will easily run down two brace before dinner. These dogs are kept by the dashing class of sportsmen, who are usually well mounted, and pride themselves on the quantity of game killed in a day. But the breed mostly used for hare-hunting are the deep-tongued, thick-lipped, broad and long-hung, southern hounds. These ordinarily give a long chase, and succeed by dint of perseverance; for their pace is rather slow, but their cry is peculiarly musical.

A middle breed is sometimes seen, having rough wire-haired backs, thick quarters, and rather thin shoulders; many suppose it to have been obtained by a cross with the Pomeranian dog, or the Russian hound. The whole may be mixed without disadvantage. There is another sort, preferred from their acuteness of smelling, and because they are easily subsisted; but they are apt to be great chatterers: these are very small, fine boned, long eared, and peculiarly handsome in their fore-quarters. The late Colonel Hardy had a cry consisting of about eleven couples of this diminutive race, which used to be carried to and from the field in a pair of panniers, slung across a horse. They were all stolen one night, together with the panniers, and not the least trace was afforded, whereby to discover either the robbers or their booty. As that gentleman resided not far from the coast, it is probable his pigmy pack were sentenced to transportation beyond sea; and, no doubt, fetched a good price on the continent.

The nature of the country should determine with regard to the choice of hounds. Where the dogs are very fleet, and the country well inclosed, they act nearly on a par with slower hounds in an open district. When a dog is too fleet for the pack, he should be loaded with a collar, filled with small shot, so as to make him carry weight, and bring him down to the level of speed. When a hound is too slow, he should be drawn, unless he happens to be peculiarly well gifted; in which case, though he will constantly tail, (or lag,) he will rarely fail, when the precursors are at fault, to dash through them without losing the scent, and thus set the pack on the cry again.

The choice of a hound, of whatever breed, may be summed up in a few words: select the dog of a middle size, broad backed, wide nostrils, capacious

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and deep chest, fillets great and high, haunches large, hams straight, well-curved rump, round feet with firm dry soles, large claws, broad ears, full eyes, and a heavy upper lip. But with all this form, he will not be worth a groat, if his olfactory powers be defective, if he be given to babble, or that he steals away after his game without giving tongue. Many dogs, however, of great value, run mute, but they possess fine action, and always show themselves to be on scent, or eventually whimper as they hit it off.

Young hounds should always be trained to some particular branch of sporting, and not be suffered, as is too often the case, to hunt either foxes or hares, as chance may present; such dogs are always unsteady and unmanageable. Enter the pups at a year old, if possible, in a country where the runs are not severe; but always have an eye to training them in a close or open country, according as that part is where they are permanently to hunt: for a dog taken from an open to a close country, or *vice versa*, will never hunt with so much spirit as those trained on the spot.

It is remarkable that hares run hardest, and puzzle most, at the full of the moon; they have always more scent in going to, than from, their forms; both because they are then warmer, and because they usually approach their seats slower than they quit them: but a hare generally springs into her form from some distance. When the huntsman is certain of a hare in any particular covert, he should lead his dogs compactly thereto, and give her the chance of going off with all advantage: he must never baulk her by crossing her usual sortie, for in such case she would be dismayed, and give but little sport. It is, indeed, usually best to alarm the hare by the gradual approach of the pack, which she will soon wind, or hear, and thus to give her a fair start, that she may go off deliberately, and not be blown by an early view.

Hares generally make a circular tour; and, for the most part, endeavour to return to their haunts. Hence many a fine chase has been seen from a rising ground. It sometimes happens that a hare "flies the country;" that is, goes off straight: when this happens, the hare is generally a rambler from some other covert, and exerts all her speed to return thereto. The first ring a hare makes ordinarily shows where the chase will lay; for all her endeavours will be exerted to double upon her former track, and to cross the scent, so as to throw the dogs out. Such is the cunning of this animal, that it will, when close pursued, leap into high bushes, and remain there, although surrounded by dogs and huntsmen: in this manner many escape. We have heard of a hare leaping into a road-waggon, and thus evading her followers completely. Some, when running against the wind, stop short, and after allowing the hounds to pass, return secretly to their forms: this trick succeeds best when the dogs are fresh and impetuous.

The limits of our work not allowing us to enter upon all the minutiæ of hare-hunting, we must conclude this part of our subject with observing, that the most successful huntsmen always make the least noise, and not only keep others back, but invariably allow a good interval between the dogs and their own horses. By this means they often discover those tricks which a hare is apt to practise, and which with less cautious persons very generally insure her safety.

Fox-hunting is a diversion requiring considerable powers, both in the rider and in his steed: the extent of ground traversed on some occasions, and that too at more than a moderate pace, establishes the necessity for a rare combination of strength, activity, courage, and perseverance, in those who follow this laborious sport.

There are three varieties of fox with us, all differing in form, but not in colour; except the cur-fox, the tip of whose tail is black. They are distinguished by the names of the greyhound-fox, which is the tallest and boldest, is found chiefly in the mountainous parts of England and Scotland, and will attack a full grown sheep. The mastiff-fox is rather less, but his limbs are strongly formed; his shape is altogether more compact, and he is perhaps as stout as the species above mentioned: this variety is not very common. The kind mostly found by sportsmen is the cur-fox, which, though of smaller stature than either of the foregoing, is most pernicious to game, and infests all places where poultry, or any animals it can master, are kept. All foxes are peculiarly alarmed by the discharge of fire-arms, and quit those earths which smell of gunpower: hence, fumigating with sulphur is resorted to as the certain means of expulsion. When pressed by hunger, foxes will eat snails, slugs, beetles, berries of various kinds, crabs, shrimps, &c. and sometimes carrion; but

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they prefer warm flesh, and that too of their own killing.

The fox knows how to secure a good asylum, either by digging holes, or by following crevices among rocks, roots of trees, &c. with many apertures, so as to favour escape, or entrance, when in danger; or, eventually, he steals into the den of some badger, occasioning that animal to quit it, and then enlarges, or alters, the interior according to his own fancy. When chased, he generally flies the country to some strong covert, endeavouring to shelter himself in some other earths; in which, however, he cannot remain when heated with running; but he sometimes succeeds by swimming across streams, or by climbing trees, or to the tops of barns, &c. Sometimes, though not often, he will lead back to his own earths, where he may expect certain death.

It is usual, when the fox-hounds are to go out, to send out the earth-stoppers during the preceding night: these repair to the several haunts, and close the entrances while the foxes are abroad in search of prey. The cunning animal, finding the work of man about his premises, retires to some furze, hether, or coppice, not far off, where he is sure to be started by the dogs; and to be followed, indeed sometimes pointed out, by the jays, blackbirds, crows, magpies, and other birds, which consider him as their common enemy. When attacked, he fights in silence, but with astonishing courage, regardless of pain, and rarely quitting his hold. When seized by the hounds it is rarely that he cries out; though he snarls and snaps with peculiar expression and indescribable ferocity.

It is highly necessary in training fox-hounds, to keep them entirely to the pursuit of foxes; if suffered once to follow a hare, their staunchness will be in danger of diminution. A hound for this sport should be of rather a large size, full of blood, light, but strong in the limbs, great speed, and of distinguished perseverance. If deficient in either of these requisites, he must be drawn. He may make a good harrier, under certain circumstances, but will be a great detriment to the fox-pack. Nor is the keenness of scent an object of less importance; indeed, it is of more moment than among harriers; for the fox will play off an infinity of devices, especially that of running on a dusty road, crossing broad waters, springing over wide ditches, passing along the copings of park-walls, &c. that require an acute sense of smelling to defeat: add to this, he is often a mile a-head of the hounds, whereby the trail loses greatly of its strength.

In following fox-hounds, the sportsman has little time for deliberation: he must keep up as well as he can, taking care to keep the cry in hearing, and avoiding leaps and scrambles as much as he can. It is true, this doctrine is by many held to be effeminate, and unbecoming the keen hunter; but it is the way to be in at the death, and to enjoy the chase without injuring the horse. Fox-hounds spread much more than harriers, on account of the diversity of country they run through: hence there is often a mile, or more, between the first and last dog; considering even the hindmost as well laid in, and rejecting such as are faulty. With regard to the extent of riders, no computation can be offered; it sometimes reaching from the place where the game started to where it died, or was lost.

Foxes are wonderfully sagacious; they have been carried sixty and seventy miles in hampers, for the purpose of being hunted by some distant pack; and after escaping, in various successive instances, have been retaken at their original haunts. This seems to prove that foxes are great ramblers, and are in general well acquainted with a very large tract around their usual haunts. Perhaps the following may show their great cunning better than any instance hitherto offered to the public: it is taken from Daniel's "Rural Sports," and is considered to be strictly correct. "A fox, being hard run, took shelter under the covering of a well, and by the endeavours used to extricate him, was precipitated to the bottom, a depth of one hundred feet. The bucket was let down, he laid hold of it, and was drawn up for some way, when he again fell. The bucket being let down a second time, he secured his situation in it, was drawn up, again turned off, and fairly beat the hounds." This occurrence is said to be well known at Imber, in Wiltshire, where the well is often shown to the curious.

Wolf-hunting, fortunately for the inhabitants of Britain and Ireland, is now become obsolete, by the total extinction of that animal among us. Wolf-dogs are, however, retained by some gentlemen as curiosities: they are said to be the most faithful animals of the canine race, and possessed of wonderful powers in regard to hitting off a cold scent.

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Boar-hunting forms no part of the British field sports, though pursued in some parts of the continent with the utmost keenness, and on a grand scale. In Germany, especially, the chase after the wild-boar forms a grand feature of national sports, and is attended with great preparation and expense. The haunts of those animals are first ascertained, after which a host of hunters throng to the woods, some mounted, and some on foot, to rouse and attack the bristled game. All are armed from head to foot, and take care to have some lusty trees at hand, behind which they may take refuge when the boar charges. The danger arises, however, less from the animal, than from the number of random shots fired at him, without any attention to what persons may be in the line of aim; numbers are thus wounded, and even killed outright, in this desperate species of pastime.

Nor is *Tiger-hunting* attended with less risk; for, in addition to the above negligence, the danger of being run away with by the elephant, on which the sportsman must be mounted, is to be considered. The tiger is usually roused from his the jungle of underwood, or from his haunt among grass of a prodigious height, covering immense tracts of land. Few elephants can be brought to face him; and, when they can, it often happens that the tiger's claws repel the attack, or that, by springing upon the back of the stupendous quadruped, he dislodges the driver, or the sportsman and his attendant. It is, however, a fact, that fewer persons are destroyed, or maimed, in either boar or tiger-hunting, than meet their deaths in fox-hunting. But even that hazardous diversion may be considered as safe, when compared with

Stag-hunting, in which great speed is indispensable, and no hesitation can be admitted by any person desirous of witnessing the various bold and elegant variations in the stag's career. For this sport, hounds of large stature, great powers, and extraordinary courage, are indispensable; for when the stag sails, (*i. e.* takes to the water) he must be followed without delay: when at bay, (*i. e.* standing on his defence, probably with his rump towards a tree) he will make desperate attacks on his pursuers; frequently tossing many of the dogs, and goring the horses of such as approach him incautiously. Many hunt stags with what are called stop-hounds: which implies, that whenever the stag is to be saved, the huntsman heads the pack, and throws a pole, on which the whole desist from the pursuit. This may be needful where the game is not abundant, but requires much management and great assiduity to effect.

We fear the taxes laid on horses and dogs, added to the expense of the necessary certificate, trench deeply on the enjoyment of rural sports, by those who are qualified, and operate considerably in favour of poachers, who thus have the game, in a measure, preserved for them; and are sure of a sale for their ill-gotten gains, among families which formerly could always obtain a hare, or a brace of birds, without expense, and the result of a healthy mode of amusement.

SPOTS, in astronomy, certain places of the Sun's or Moon's disk, observed to be either more bright or darker than the rest, and accordingly called faculæ and maculæ. See FACULÆ and MACULÆ.

SPRAT. See CLUPEA.

SPRAY, the sprinkling or foam of the sea, which is driven from the top of a wave in stormy weather. It differs from what sailors call spoon-drift, as being blown occasionally from the broken surface of a high wave; whereas the latter continues to fly horizontally along the sea, without intermission, during the excess of the tempest or hurricane.

SPRING, in natural history, a fountain or source of water, rising out of the ground. Various have been the opinions of philosophers concerning the origin of springs; but those which deserve notice are only the three following ones: 1. That the sea water is conveyed through subterraneous ducts, or canals, to the places where the springs flow out of the earth; but as it is impossible that the water should be thus conveyed to the tops of mountains, since it cannot rise higher than the surface, some have had recourse to subterraneous heats; by which, being rarefied, it is supposed to ascend in vapours through the bowels of the mountains. But as no sufficient proof is brought of the existence of these central heats, or of caverns in the mountains big enough to let the vapours ascend, supposing such heats, we shall not take up our reader's time with a formal refutation of this hypothesis. 2. As to those who advance the capillary hypothesis, or suppose the water to rise from the depths of the sea, through the porous parts of the earth, as it rises in capillary tubes, or through sand or ashes, they seem not to consider one principal property of this kind of tube, or this sort of attraction: for though the water rise to the top of

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the tube or sand, yet will it rise no higher, because it is by the attraction of the parts above that the fluid rises, and where that is wanting it can rise no further. Therefore, though the waters of the sea may be drawn into the substance of the earth by attraction, yet it can never be raised by this means into a cistern, or cavity, to become the source of springs. 3. The third hypothesis that of the sagacious naturalist, Dr. Halley, who supposes the true sources of springs to be melted snow, rain-water, dew, and vapours condensed.

Now in order to prove that the vapours raised by the heat of the sun from the surface of the seas, lakes, and rivers, are abundantly sufficient to supply the springs and rivers with fresh water, the doctor made the following experiment: he took a vessel of water, made of the same degree of saltness with that of the sea, by means of the hydrometer; and having placed a thermometer in it, he brought it, by means of a pan of a coals, to the same degree of heat with that of the air in the ho test summer. He then placed this vessel, with the thermometer in it, in one scale, and nicely counterpoised it with weights in the other: after two hours he found that about the sixtieth part of an inch was gone off in vapour, and consequently, in twelve hours, the length of a natural day, one tenth of an inch would have been evaporated. From this experiment it follows, that every ten square inches of the surface of the water yield a cubic inch of water in vapour per day, every square mile 6,914 tons, and every square degree (or 69 English miles) 33 millions of tons. Now, if we suppose the Mediterranean to be 40 degrees long, and 4 broad at a medium, which is the least that can be supposed, its surface will be 160 square degrees, from whence there will evaporate 5280 millions of tons per day in the summer time. The Mediterranean receives water from the nine great rivers following, *viz.* the Iberus, the Rhine, the Tiber, the Po, the Danube, the Neister, the Borysthenes, the Tanais, and the Nile; all the rest being small, and their water inconsiderable. Now let us suppose that each of these rivers conveys ten times as much water to the sea as the Thames; which, as is observed, yields daily, 76,032,000 cubic feet, which is equal to 203 millions of tons; and therefore all the nine rivers will produce 1827 millions of tons; which is little more than one third of the quantity evaporated each day from the sea. The prodigious quantity of water remaining, the doctor allows to rains, which fall again into the seas, and for the uses of vegetation, &c. As to the manner in which these waters are collected, so as to form reservoirs for the different kinds of springs, it seems to be this: the tops of mountains, in general, abound with cavities, and subterraneous caverns formed by nature to serve as reservoirs; and their pointed summits, which seem to pierce the clouds, stop those vapours which fluctuate in the atmosphere, and being constipated thereby, they precipitate in water, and by their gravity easily penetrate through beds of sand and lighter earth, till they are stopped in their descent by more dense strata, as beds of clay, stone, &c. where they form a basin or cavern, and work a passage horizontally, and issue out at the side of the mountain. Many of these springs running down by the vallies, between the ridges of hills, and uniting their streams, form rivulets or brooks; and many of these, again uniting on the plain, become a river.

Springs are either such as run continually, called perennial; or such as run only for a time, and at certain seasons of the year, and therefore called temporary springs. Others again are called intermitting springs, because they flow and then stop, and flow and stop again: and, finally reciprocating springs, whose waters rise and fall, or flow and ebb, by regular intervals. To account for these differences in springs, see HYDRAULICS.

SPRING, in mechanics, denotes a thin piece of tempered steel, or other elastic substance: which being wound up, serves to put several machines in motion by its elasticity, or endeavour to unbend itself; such is the spring of a clock, watch, and the like. The spring of a lock, gun, pistol, or the like, is a piece of steel violently bent; which, being set at liberty, beats back the bolt of the lock, or strikes down the cock.

SPRING, in naval affairs, a crack running transversely, or obliquely, through any part of a mast or yard, so as to render it unsafe to carry the usual quantity of sail thereon. Spring is also a rope passed out of a ship's stern, and attached to a cable proceeding from her bow when she lies at anchor. It is usually performed to bring the ship's broadside or battery of cannon to bear on some distant object, as another ship, a fortress on the coast, &c. When a ship rides by anchors which are only attached to one end, she will move like a weather-cock, according to the direction of the wind or tide. Now,

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if a rope be extended from the other end to the same anchor, it is evident that by slackening one of these ropes, and keeping fast the other, her side will lie more or less obliquely to the wind or tide, as occasion may require, so as to be opposed to any distant object to the right or left. For instance, if a ship ride with her head northerly, and it is required to cannonade a fortress lying on the south or south-east, a hawser is run out of the stern, and being carried forward without her fid, is attached to the cable at a competent distance a-head of the ship; the hawser is then tightened by the capstain or tackles, and the cable being slackened, the ship immediately turns her side towards the object intended to be battered.

SPRIT, in naval affairs, a small boom or pole, which crosses the sail of a boat diagonally from the mast to the upper aftmost corner, which it is used to extend and elevate; the lower end of the sprit rests in a sort of wreath, which encircles the mast at that place.

SPRUCE *beer*, a cheap and wholesome liquor, which is thus made: take of water sixteen gallons, and boil the half of it. Put the water thus boiled, while in full heat, to the reserved cold part, which should be previously put into a barrel or other vessel; then add sixteen pounds of treacle or molasses, with a few table spoonfuls of the essence of spruce, stirring the whole well together; add half a pint of yeast, and keep it in a temperate situation, with the bunghole open, for two days, till the fermentation be abated. Then close it up, or bottle it off, and it will be fit for being drunk in a few days afterwards. In North America, and perhaps in other countries, where the black and white spruce firs abound, instead of adding the essence of the spruce at the same time with the molasses, they make a decoction of the leaves and small branches of these trees, and find the liquor equally good. It is a powerful antiscorbutic, and may prove very useful in long sea-voyages.

SPUNGE. See Spongia.

Spunge, is also used, in gunnery, for a long staff or rammer, with a piece of sheep or lamb-skin wound about its end, to serve for scouring great guns, when discharged, before they are charged with fresh powder.

SPUNGING, in gunnery, the cleaning a gun's inside with a sponge, in order to prevent any sparks of fire from remaining in her, which would endanger the life of him who should load her again.

SPUN *yarn*, among sailors, is a kind of line made from rope-yarn, and used for seizing or fastening things together.

SPUR, a piece of metal, consisting of two branches encompassing a horseman's heel and a rowel in form of a star, advancing out behind, to prick the horse.

SPY, a person hired to watch the actions, motions, &c. of another; particularly of what passes in a camp. When a spy is discovered, he is hanged immediately.

SQUADRON, in military affairs, denotes a body of horse, whose number of men is not fixed; but is usually from one to two hundred. Each squadron usually consists of three troops, of fifty men each.

In naval affairs, a squadron either implies a detachment of ships employed on any particular expedition, or one-third part of a naval armament.

SQUALUS, the *shark*, in natural history, a genus of fishes of the order Cartilaginei. Generic character: mouth under the fore part of the head, with teeth disposed in rows, and partly moveable and partly fixed; generally five spiracles, at the sides of the neck, of a semilunar shape; body oblong, rather cylindric and rough, with tender prickles. These animals are never found in rivers or lakes, inhabiting only the sea, and carrying terror and destruction wherever they appear. They grow, in some species, to the weight of three or four thousand pounds. They occasionally emit a phosphoric illumination, visible by night. They produce their young alive, several at a birth, but every one inclosed in a transparent horn-like substance, lengthened at the extremity into a thread, which attaches to fixed substances, such as rocks or weeds. Some appear to live on vegetables chiefly, but the greater number are rapacious of animal substances in the extreme. They seize, indeed, whatever they find, with the most violent avidity, following in the wakes of ships, for the sake of nearly every thing thrown from them, and are fatal to those mariners who slip from their hold on the rigging into the sea, in which case the sharks are seen to tear them to pieces, with all the violence of competition. They are in most instances solitary wanderers through the ocean, but in some species are gregarious. They contain large quantities of oil, and their skin is convertible to several useful purposes.

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There are thirty-four species. The following are the most entitled to attention. S. carcharios, or the white shark, attains sometimes the length of thirty feet, and is the most fierce and rapacious inhabitant of the ocean, in the depths of which, particularly in the warmer latitudes, it principally ranges. According to some writers, a man, and even a horse, has been found entire in the body of one of these animals; and the teeth of this, or some larger species, are exhibited in the British Museum, four inches and a half in depth. The intestines of this animal generally contain a vast number of tape worms, which may account, in some degree, for its peculiar voracity.

S. maximus, or the barking shark, is about the size of the former, and is often seen near the Hebrides in small shoals of six or eight, but generally in single pairs. These have nothing of the fierceness of the former species, and will suffer themselves to be handled without resistance. They subsist on sea-weeds, and their stomachs have never exhibited indications, on being opened, of any other substances. They often sport about the billows with great agility and appearance of delight, and will suffer a boat to approach them so nearly, that the harpooner may pierce them with the instrument in his hand. But it is stated that the wounds thus inflicted often excite at first no symptom of pain, and that in some cases no appearance of this is indicated, till the combined efforts of two men have urged the instrument to its fullest depth, when they exhibit extreme agitation and rapidity, traversing the water with the most turbulent movements, and summoning into exercise, for many hours, all the skill and energy of those engaged in this critical pursuit. See Pisces, Plate VI. fig. 1.

S. glaucus, or the blue shark, is the most elegantly shaped and coloured of all the species, is about ten feet long, and found in almost every sea. In the season for pilchards it abounds on the coast of Cornwall, and is often taken with large iron hooks.

S. stellaris, or the greater spotted dogfish, is a native of the seas of Europe. It seldom exceeds in length six feet. Its snout is considerably elongated, whence it derives its designation of the dog fish. It is found chiefly in rocky situations, and preys upon various shell-fish. It produces nineteen at a birth, but does not appear extremely abundant. Its flesh is eaten, and its skin is an article of commerce.

S. zygæna or, the hammer-headed shark, is sixteen feet long, and inhabits the Mediterranean and Indian seas, where its depredations are incessant and most formidable. It is distinguished by its head being dilated on the sides to an extraordinary extent, and by the eyes being at the extremities of these sides.

S. squatina, or the angel fish, is distinguished by a large and flat head, rounded in front, is found in the European seas, and grows to the length of seven feet. It is highly fierce and formidable.

SQUALL, in naval language, is a sudden violent gust of wind, usually occasioned by the interruption and reverberation of the wind from high mountains. Squalls are very frequent in the Mediterranean, particularly in the Levant, and are supposed to be produced by the new direction which the wind meets with in its passage between the various islands of the Archipelago.

SQUARE, in geometry, a quadrilateral figure, both equilateral and equiangular. To find the area of a square, seek the length of one side; multiply this by itself, and the product is the area of the square.

SQUARE *number*, the product of a number multiplied into itself. Thus 4, is the product of 2 multiplied by 2; or 16, the product of 4 multiplied by 4, are square numbers.

The series of square integers, is .	1, 4, 9, 16, 25, 36, &c.
which are the squares of . .	1, 2, 3, 4. 5, 6, &c.
Or the square fractions . . .	$\frac{1}{4}$, $\frac{4}{9}$, $\frac{9}{16}$, $\frac{16}{25}$, $\frac{25}{36}$, $\frac{36}{49}$, &c.
which are the squares of . .	$\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$, $\frac{6}{7}$, &c.

A square number is so called, either because it denotes the area of a square, whose side is expressed by the root of the square number; as in the annexed square, which consists of nine little squares, the side being equal to three; or else, which is much the same thing because the points in the number may be ranged in the form of a square, by making the root, or factor, the side of the square.

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Some properties of squares are as follow: 1. Of the

Natural series of squares $1^2, 2^2, 3^2, 4^2$, &c. which are equal to . 1, 4, 9, 16, &c.

The mean proportional $m\,n$ between any two of these squares m^2 and n^2, is equal to the less square plus, its root multiplied by the difference of the roots; or also equal to the greater square minus, its root multiplied by the said difference of the roots. That is

$$m\,n = m^2 + d\,m = n^2 - d\,n;$$

where $d = n - m$ is the difference of their roots.

2. An arithmetical mean between any two squares m and n^2, exceeds their geometrical mean, by half the square of the difference of their roots.

That is $\frac{1}{2}m^2 + \frac{1}{2}n^2 = m\,n + \frac{1}{2}d^2$.

3. Of three equidistant squares in the series, the geometrical mean between the extremes is less than the middle square, by the square of their common distance in the series, or of the common difference of their roots.

That is, $m\,p = n^2 - d^2$;

where m, n, p, are in arithmetical progression, the common difference being d.

4. The difference between the two adjacent squares m^2 and n^2, is $n^2 - m^2 = 2m + 1$; in like manner, $p^2 - n^2 = 2n + 1$, the difference between the next two adjacent squares n^2 and p^2; and so on, for the next following squares. Hence the difference of these differences, or the second difference of the squares, is $2n - 2m = 2 \times \overline{n - m} = 2$ only, because $n - m = 1$; that is, the second differences of the squares are each the same constant number 2; therefore the first differences will be found by the continual addition of the number 2; and then the squares themselves will be found by the continual addition of the first difference; and thus the whole series of squares is constructed by addition only, as here below:

2d Diff.		2	2	2	2	2	2	&c.
1st Diff.	1	3	5	7	9	11	13	&c.
Squares	1	4	9	16	25	36	49	&c.

5. Another curious property, also noted by the same author, is, that the sum of any number of the cubes of the natural series 1, 2, 3, 4, &c. taken from the beginning, always makes a square number, and that the series of squares, so formed, have for their roots the numbers . . . 1, 3, 6, 10, 15, 21, &c. the diffs. of which are 1, 2, 3, 4, 5, 6, &c. *viz.*

$1^3 = 1^2$,

$1^3 + 2^3 = 3^2$,

$1^3 + 2^3 + 3^3 = 6^2$,

$1^3 + 2^3 + 3^3 + 4^3 = 10^2$; and the general $1^3 + 2^3 + 3^3 + n^3 = (1 + 2 + 3 + n)^2 = \frac{1}{2}\,n.n + 1$; where n is the number of the terms or cubes.

Squaring the circle, is the making or finding a square whose area shall be equal to the area of a given circle. The best mathematicians have not yet been able to resolve this problem accurately, and perhaps never will. But they can easily come to any proposed degree of approximation whatever; for instance, so near as not to err so much in the area as a grain of sand would cover, in a circle whose diameter is equal to that of the orbit of Saturn. The following proportion is near enough the truth for any real use, *viz.* as 1 is to .88622692, so is the diameter of any circle to the side of the square of an equal area. Therefore, if the diameter of the circle be called d, and the side of the equal square s;

then is $s = .88622692d = \frac{39}{44}d$ nearly.

$$\text{and } d = \frac{s}{.88622692} = \frac{44}{39}s \text{ nearly.}$$

Square *root*, a number considered as the root of a second power or square number; or a number, by whose multiplication into itself a square number is generated.

Square *battle*, or *Battalion of Men*, is one that hath an equal number of men in rank and file.

Square, *hollow*, in the military art, is a body of foot drawn up with an empty space in the middle for the colours, drums, and baggage; faced and covered by the pikes every way, to keep off horse.

Square, an instrument consisting of two rulers, or branches, fastened perpendicularly at one end of their extremes, so as to form a right angle; it is of great use in the description and mensuration of right angles, and laying down perpendiculars.

Square, in naval affairs, is a term peculiarly appropriated to the yards and their sails, either implying that they are at right angles with the mast or keel;

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or that they are of greater extent than usual.

SQUIRREL. See Sciurus.

STACHYS, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ, or Labiatæ. Essential character: corolla upper lip arched; lower reflexed at the sides; the middle segments larger, emarginate; stamens finally reflexed towards the sides. There are twenty-four species.

STÆHELINA, in botany, so named from John Henry Stæhelin and his son, Swiss physicians, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Discoideæ. Cinarocephalæ, Jussieu. Essential character: anthers tailed; down branched; receptacle with very short chaffs. There are ten species.

STAFFA, an island situated on the coast of Scotland, three miles north-east of Iona or Columb-kill, and west of Mull, about a mile in length, and half a mile in breadth, belonging to Mr. Lauchlin Mac Quarie. This inconsiderable isle is one amongst the most wonderful productions of nature, and deserves the attention of every natural philosopher, though it is unfortunately placed in a region which prevents frequent visits, even from curious investigators. The peculiarity that renders it so interesting, arises from the basaltes composing it assuming a number of magnificent forms, equally astonishing and sublime; but as we purpose to describe them with some degree of minuteness, it will be proper to give a general sketch of the nature of the substance termed basaltes, and where it abounds, that the subject may be clearly understood. See Basaltes.

According to Strabo and Agricola, the antique basaltes is found in the same prismatical form in Egypt, which distinguishes its outline in various parts of Europe. Farber, a professor of natural history at Mietau, supposes that found in the Vicentine Paduan and Veronese districts of Italy to be a crystallized lava, and asserts, that the antique basaltes is in every respect exactly similar to the compact lavas of Vesuvius and Monte Albano, which are used by statuaries to restore mutilated statues made of this material.

The Egyptian basaltes contain a small proportion, in some of the varieties, of the white garnet like shorl crystallizations and lamellas common in the Italian lavas, a circumstance that seems to prove to demonstration their volcanic production in these particular instances, though others of the oriental basaltes seem to have originated from aqueous mixtures.

Dr. Von Troil, member of the Academy of Sciences at Stockholm, entertained an opinion that they were caused by the operations of fire, which he founded on that of M. Desmaret, who was the first naturalist that ventured to attribute them to that cause, in a description of some basaltes, found near St. Sandour, in Auvergne, presented by him to the attention of the French Academy of Sciences. Other naturalists, who had considered them to be a species of crystallization, ridiculed this idea as founded upon false principles, as they contended basalt pillars are discovered where it seemed highly improbable that volcanoes could ever have existed; still, however, they had the candour to enter into an examination of the assertion of M. Desmaret, the result of which was nearly a confirmation of his conjecture, that basalt pillars were produced by subterraneous fires. As a collateral support of this hypothesis, Dr. Von Troil cites the instances of Stolpenstein in Meissen, Lauban in Lusatia, of Bohemia, Leignitz in Silesia, Brandau in Hessia, Sicily, Bolsenna, Montebello, and St. Forio in Italy; the district of Vicenza, Monte Rosso, in the District of Padua, Monte Diavolo in the mountains of Verona, in Lower Languedoc, in Ireland, and in the western islands of Scotland, in each of which places, he says, a doubt cannot be entertained that volcanoes have existed; besides those, he mentions St. Giovanni, Monte Castillo, Monte Nuovo, Monte Oliveta, near Cader Idris, in Wales, and almost every part of Velay and Auvergne, where the towns of Chillac and St. Fluor are situated upon basaltes.

The peasantry of Iceland seem to have entertained a similar opinion of their origin to that of the lower orders of the Irish, as the former suppose them to have been piled, in the regular manner they are seen there, by giants, and thence call them Trollahland and Trollkonugardur, and the latter term their magnificent causeway, the Giant's. The pillars of the Icelandic basaltes have generally from three to seven sides; they vary in thickness from four to six feet, and some are of thirty-six, and others even forty-eight feet in length, without horizontal divisions; but such are the capricious operations of nature, that pillars are sometimes

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found not more than six or twelve inches long; those, however, are invariably very regular, and are made use of for doors and windows; at others they appear in the utmost confusion, broken, and overturned; in particular instances they just appear above the surface of the mountains, amongst lava and tufa, and there are places where they extend three miles together without interruption. The basalt pillars of Glockenberg in Snefialdsnas, exhibit a very different appearance from those of any other part of Iceland, as the pillars on the summit of that mountain lie horizontally, those on the sides incline, and the lowest stand erect. In some places they are found as if bent, when heated, into a semicircular form, an effect which seems to confirm the idea that violent fires have prevailed, either at their formation, or subsequently.

The substance of the pillars of this island resemble those of Staffa in some parts of it, but in others they are more porous, and incline more to a grey colour. This circumstance induced the Doctor to think it would be an easy matter to trace all the gradations between the most perfect basalt pillar and the coarsest description of lava, and he even saw some at Videy, of a fine grain, extremely solid, of a blackish grey, and consisting of many joints; some porous glassy kind of stone, which he found at Laugarnas, near the sea, was so indistinctly divided, that he was undecided whether to class it with the lavas or basalt pillars; but the opinion of his friends determined him in favour of the latter.

We have been the more particular in noticing the peculiarities of the basaltes of Iceland, as that island is situated in the vicinity of Staffa, to which we shall now turn our attention. The gentleman we have just mentioned was one of the first persons who had the good fortune to examine the latter with any degree of accuracy; nor indeed had the public been informed before of the distinguishing marks which render it so highly interesting, Buchanan being then the only author that had noticed this beautiful work of nature, though very slightly. Mr. Pennant, who possessed every requisite talent for informing the world, was disappointed by an adverse wind, from visiting Staffa in the year that proved more favourable to Dr. Von Troil, who would have been exactly in the same situation, in all probability, had not the tide, which flows with great strength between the western isles of Scotland, compelled the captain of the vessel employed to take him to Iceland to anchor on the night of the twelfth of August, in the sound between the Isle of Mull and Morvern on the continent, and precisely opposite to Drumnen, the seat of Mr. Maclean, by whom the Doctor and his friends were immediately invited on shore to breakfast, with the characteristic hospitality of the Highlanders. Mr. Banks, now Sir Joseph, being of the party intending to visit Iceland, eagerly accepted, with the Doctor, and others, the offer of Mr. Maclean to conduct them to Staffa, to which they were conveyed by the ship's long boat the same evening, about nine o'clock. "It was impossible," says the Doctor "for our surprise to be increased, or our curiosity to be fuller gratified than they were the next morning, when we beheld the no less than beautiful spectacle which nature presented to our view. If we even with admiration behold art, according to the rules prescribed to it, observing a certain kind of order, which not only strikes the eye, but also pleases it, what must be the effect produced upon us when we behold nature displaying, as it were, a regularity, which far surpasses every thing that art ever produced? An attentive spectator will find as much occasion for wonder and astonishment, when he observes how infinitely short human wisdom appears, when we attempt to imitate nature in this as well as any other of her grand and awful productions; and though we acknowledge nature to be the mistress of all the arts, and ascribe a greater degree of perfection to them, the nearer they approach and imitate it, yet we sometimes imagine that she might be improved, according to the rules of architecture. How magnificent are the remains which we have of the porticoes of the ancients, and with what admiration do we behold the colonnades that adorn the principal buildings of our times; and yet every one who compares them with Fingal's cave, formed by nature in the Isle of Staffa, must readily acknowledge, that this piece of nature's architecture far surpasses every thing that invention, luxury, and taste, ever produced among the Greeks."

A small cave on the west side of the island affords a convenient landing place, but there are no regular basalt pillars to be met with in its immediate vicinity. On the south side of it are some narrow pillars, which are inclined, and resemble the springs of the ribs of an arch; beyond those is a small grotto, on the right hand, not composed of pillars, though they ap-

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pear above it, disposed in the manner of the interior parts of the timbers of a ship. At a few yards distance, and opposite to the grotto, extends the peninsula of Bo-scha-la, consisting of regular, but smaller pillars, which are all of a conical figure. Some of these diverge as from a centre, some incline, and others, and by far the greater number, are perpendicular. The island itself, opposite to Bo-scha-la, is composed of thick columns, which extend into the sea as far as the eye is able to penetrate, but are not very high, and gradually decrease as they approach the water. Their relative connection is so admirably preserved, that a person may walk upon their ends as conveniently as if ascending or descending the steps of a staircase; these lead to Fingal's, or Finhn Mac Coul's cave or grotto, which is excavated out of that mountain from north-east to east.

The cave is formed by regular pillars, extending to a great distance on each side, which support an arch composed of the obtuse points of others, placed very close together; unfortunately the floor of this wonderful place is covered by a body of clear fresh water, several feet in depth, through which may be seen an incredible number of fragments of pillars. The colour of the columns is grey, inclining to black, and the joints are distinguishable by the intervention of a yellow stalactic quarry rind, that exhales, and serves to make the separations more distinct, at the same time that it produces an agreeable effect by many different gradations of colour.

A sufficient degree of light enters the cave to illuminate it to the extremity, where the ranges of pillars are perfectly discernible, and the ebbing and flowing of the tide constantly conveying and discharging air from within it, is at all times fit for respiration, and by no means noxious. This circumstance may still further originate from the passage of the water through a fissure in the rocks, rather lower than the surface, which occasions a rushing sound upon each rise of the tide, that contributes to render the effect of the whole still more singular and impressive. A boat is certainly the most convenient for visiting Fingal's cave, but it is possible to walk into it, upon the points of some of the pillars which are higher than the level of the water.

The party already mentioned measured the dimensions of this beautiful grotto, and we acknowledge ourselves indebted to Dr. Von Troil for the following particulars:

	Ft.	In.
The length from the furthest of the basalt pillars, which from the shore formed a canal to the cave, 121 ft. 6 in.; from the commencement of the vault to the end of the cave, 250 ft.	371	6
The breadth of its entrance -	53	7
Of the interior end - - - -	20	0
The height of the vault at the entrance of the cave - - -	117	6
Of ditto at the interior end - -	70	0
The height of the outermost pillar in one corner - - - -	39	6
The height of another in the north-west corner - - - -	54	0
The depth of the water at entrance - - - - - - -	18	0
Of the inside end - - - - -	9	0
From the water to the foot of the pillars - - - - - - -	36	8
Height of the pillars - - - -	32	6
Height of the arch, or vault, above the top of the pillars -	31	4
The stratum above - - - -	34	4

The western corner of Fingal's cave.

From the water to the foot of the pillars - - - - - - - -	12	10
Height of the pillars - - - -	37	3
The stratum above them - -	66	9
Further west—the stratum beneath the pillars - - - -	11	0
Height of the pillars - - - -	54	0
The stratum above - - - -	61	6
Still more westward—stratum beneath the pillars - - - -	17	1
Height of the pillars - - - -	50	0
The stratum above them - -	51	0
More west—stratum beneath the pillars - - - - - - - -	19	8
Height of the pillars - - - -	55	1
The stratum above - - - -	54	7

The stratum beneath the pillars was considered by the party to be no other than tufa, which being heated at the period when this phenomenon was produced, received into its depths fragments of basalt; that above them tinged with red, appears to be lava, containing other fragments scattered in various unequal directions; although it is evident the most violent heat must have acted upon it, yet there are not the least traces in its exterior, the pillars having been removed by it, for the whole enormous mass rests upon them.

On the north side of the island is ano-

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ther cave, called Corvoranti, where the stratum is raised, and the pillars consequently appear shortened; those are tolerably distinct, and continue so till the intervention of a bay, that extends some distance inland, and there the pillars are discontinued. The mountains in this neighbourhood are composed of dark brown stone, which may or may not be lava: but there is no sort of regularity observable in its texture. On passing further, and on the south-east side of the Island, the basalt columnar appearance commences, though almost imperceptibly; hence they gradually assume their characteristic form, till at last the spectator finds himself on the spot where they are in full perfection.

The shape of the columns vary from three to seven sides, though the majority have five and six; the former are so numerous, that a heptagonal pillar is surrounded with seven others, which join closely to its seven sides. In some instances inconsiderable fissures may be perceived, but those are generally filled with quartz, and in one particular place that had penetrated through several pillars, without interrupting the regularity of their arrangement; one of the greatest wonders attending this operation of nature, is, the separation of each pillar into pieces, which are so closely jointed, that it is almost impossible to introduce a knife between the interstices. Upon an attentive examination of many of those pieces, it was found that the uppermost was generally concave, in some cases flat, but very rarely convex. When the upper surface was flat, the lowest joint was the same; but when it was excavated, the lower one was rounded and reversed.

The sides of the pillars are of unequal dimensions, to prove which, we shall give the measurement of two, extracted from the Letters on Iceland, containing Dr. Von Troil's communication on this subject.

One with four sides.

	Ft.	In.
First side	1	5
Second	1	1
Third	1	6
Fourth	1	1

With seven sides.

	Ft.	In.
First side	2	10
Second	2	4
Third	1	10
Fourth	2	0
Fifth	1	1
Sixth	1	1
Seventh	1	3

The angles are as sharp and well defined as those of the pillars of the Giant's Causeway in Ireland, and their colour is generally black, the inclination to yellow being confined to the external sides, which are exposed to, and in some degree bleached by, the action of the sun, rain, and wind. The texture of their substance much resembles, and is probably the same as the Icelandic agate. Professor Bergman was divided in opinion, whether these pillars were produced by first acting upon particular substances, or whether subterraneous fires, sending forth vapour, may have softened the superincumbent earth, which becoming soft, and yielding to the force below, ascended in this peculiar form, and became gradually petrified. This latter supposition met the ideas of Von Troil, who illustrates it by saying, he has observed the distinct and regular appearance alluded to in dried clay, and even starch, when dried in a basin. "For," adds the latter, "it may be demonstated, that they are not crystals formed by nature, by their not being produced, as all other crystals are, by external apposition (per appositionem,) nor in any other matrix, as is common among crystals." He further observes, "The following may, however, serve as a proof that I did not, without due foundation, believe them to be a kind of lava, which burst in growing cold and hard. First, you find both in the Island of Staffa, and many other places, that the pillars stand on lava or tufa, and are surrounded by this matter. Secondly, at Staffa there was a large stratum above the pillars, in which there were many pieces of those pillars irregularly thrown one among another, which leaves us to conjecture that they must have been more in number, and higher, after an old eruption of fire; but that a subsequent eruption had overthrown them, and mixed them with the whole mass."

STAIRCASE, in architecture, an ascent inclosed between walls, or a balustrade, consisting of stairs, or steps, with landing-places and rails, serving to make a communication between the several stories of a house. The construction of a complete staircase is one of the most curious works in architecture.

STAKE, the name of a small anvil, used by smiths; sometimes it stands on a broad iron foot on the work-bench, to be moved up and down occasionally; and sometimes it hath a strong iron spike at the bottom, by which it is fixed to some place on the work-bench. Its use is to sit small and cold work straight, by hammer-

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ing on the stake; or to cut or punch upon the cold chissel or cold punch.

STALACTITÆ, *stony-icicles*, in natural history, crystalline spars formed into oblong, conical, round, or irregular bodies, composed of various crusts, and usually found hanging in form of icicles from the roofs of grottos, &c. Of this class there are various species, as the hard, white stalactitæ; the white, shattery stalactitæ; and the yellow, shattery, crystalline stalactitæ, &c.

STALK, in botany, that part of the plant which rises immediately from the root, and which supports the leaves of the flowers, and the fruit. See Botany.

STAMINA, in botany, *threads*, which, in most flowers, are placed round the seed-bud: they are designed for preparing the pollen, which is the chief agent in the generation of plants. The stamen is divided into the "filamentum," or slender, thread-shaped part, resembling a foot-stalk; the "anthera;" and the "pollen."

Stamina, in the animal body, are defined to be those simple original parts, which existed first in the embryo, or even in the seed; and by whose distinction, augmentation, and accretion, by additional juices, the animal body, at its utmost bulk, is supposed to be formed.

STANCHION, or *stanchions*, in a ship, those pillars which, being set up pillarwise, do support and strengthen the waist trees.

STAND, in commerce, a weight, from two hundred and a half to three hundred of pitch.

STANDARD, in war, a sort of banner, or flag, borne as a signal for the joining together of the several troops belonging to the same body. The standard is usually a piece of silk, a foot and a half square, on which are embroidered the arms, device, or cipher of the prince or of the colonel: it is fixed on a lance, eight or nine feet long, and is carried in the centre of the first rank of a squadron of horse. The standard is used for any martial ensign of horse, but more particularly for that of the general, or the royal standard: those borne by the foot are rather called colours.

The royal standard is a flag, in which the imperial ensigns of England, Scotland, and Ireland, are quartered, together with the armorial bearings of Hanover. It is never hoisted, unless when the King is on board, then it is displayed at the main-top-gallant-mast head.

Standard, in commerce, the original of a weight, measure or coin, committed to the keeping of a magistrate, or deposited in some public place, to regulate, adjust, and try the weights used by particular persons in traffic. The justness of weights and measures is of that importance to the security and good order of trade, that there is no civilized nation but make it a part of their policy, to preserve the equality thereof by means of standards. The standards of weights and measures in England are appointed, by magna charta, to be kept in the Exchequer, by a special officer, called the clerk or comptroller of the market.

The standard of gold coin is twenty-two carats of fine gold, and two carats of alloy, in the pound weight troy: and the French, Spanish, and Flemish gold are nearly of the same fineness. The pound weight is cut into forty-four parts and a half, each current for twenty-one shillings. The standard of silver is eleven ounces and two penny-weights of silver, and eighteen penny-weights of alloy of copper. Whether gold or silver be above or below standard is found by assaying, and the hydrostatical balance. See the articles Assaying and Hydrostatics.

STANDING, in the sea language. Standing part of the sheet, is that part of it which is made fast to a ring at the ship's quarter. Standing part of a tackle, is the end of the rope where the block is fastened. Standing ropes, are those which do not run in any block, but are set taught, or let slack, as occasion serves; as the sheet-stays, back-stays, or the like.

STANNARIES, the mines and works where tin is dug and purified, as in Cornwall, Devonshire, &c. There are four courts of the stannaries in Devonshire, and as many in Cornwall, and great liberties were granted them, by several acts of parliament, in the time of Edward I. &c. though somewhat abridged under Edw. III. and Charles I.

STANNUM. See Tin.

STAPELIA, in botany, so named in memory of Bodeus à Stapel, a physician of Amsterdam, a genus of the Pentandria Digynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; nectary a double little star covering the gentials. There are forty-nine species.

STAPHYLEA, in botany, a genus of the Pentandria Trigynia class and order. Natural order of Tribilatæ. Rhamni, Jussieu. Essential character: calyx five-

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parted; petals five; capsule inflated, connate; seeds two, globular, with a wart. There are three species.

STAPHYLINUS, in natural history, a genus of insects of the order Coleoptera; antennæ moniliform; feelers four; shells half as long as the body; wings folded up under the shells; tail not armed with a forceps, furnished with two exertile vesicles. There are nearly two hundred species, in three sections. A. All the feelers filiform. B. Hind feelers hatchet-shaped; fore feelers clavate. The wings of the insects of this genus are curiously pleated or convoluted beneath the short and abruptly terminated wing-sheaths. The most remarkable, as well as the largest of the British species, is the S. major, which is more than an inch long, entirely of a deep colour, and when disturbed sets up the hinder part of its body, as if in a posture of defence: it is very frequently seen, during the autumnal season, about sunny pathways, fields, and gardens, and is furnished with a large head, and very strong forcipated jaws. The insects of this whole tribe are extremely rapacious, devouring whatever insects they can catch, and frequently each other: many of them, when attempted to be caught, turn up the tail: the jaws are strong and exserted, with which they bite and pinch very hard. Most of them are found in damp places, among putrid substances, and a few upon flowers.

STAPLE primarily signifies a public place or market, whither merchants, &c. are obliged to bring their goods to be bought by the people; as the Greve, or the places along the Seine, for sale of wines and corn, at Paris, whither the merchants of other parts are obliged to bring these commodities. Formerly the merchants of England were obliged to carry their wool, cloth, lead, and other like staple commodities of this realm, in order to utter the same by wholesale; and these staples were appointed to be constantly kept at York, Lincoln, Newcastle upon Tyne, Norwich, Westminster, Canterbury, Chichester, Winchester, Exeter, and Bristol; in each whereof a public mart was appointed to be kept, and each of them had a court of the mayor of the staple, for deciding differences, held according to the law-merchant, in a summary way. The staple commodities of this kingdom are said by some to be these, *viz.* wool, leather, wool fells, lead, tin, butter, cheese, cloth, &c. but others allow only the first five to be staple commodities.

STAR, in astronomy, a general name for all the heavenly bodies which are dispersed throughout the whole heavens.

The stars are distinguished from the phenomena of their motion, &c. into fixed and erratic or wandering stars; these last are again distinguished into the greater luminaries, *viz.* the Sun and Moon; the planets, and the comets; each whereof has been fully considered and explained, under their respective articles. See Sun, Moon, &c.

As to the fixed stars, or simple stars, they are so called, because they seem to be fixed, or perfectly at rest, and consequently appear always at the same distance from each other.

An observer will first divide these stars into several classes, according to the splendour of their light; the brightest he will call stars of the first magnitude; those of the next inferior light, he will call stars of the second magnitude; and so in order to those which can barely be seen by the naked eye, which are called stars of the sixth magnitude; and those which cannot be seen but by the help of magnifying glasses are of the seventh, eighth, &c. magnitudes. Afterwards to avoid confusion, and to be able to point out any one star, without being obliged to give a particular name to each, he will divide them into separate parcels, of which he will make a particular plan; and to each of these constellations, or parcels of stars, he will assign a figure at pleasure, as that of a Ram, a Bull, a Dragon, a Hercules, &c. but so that all the stars in each of the parcels, drawn in the plan, may be enclosed in the designed figures, and correspond to the different parts from whence they take their name; for example, having drawn the figure of a bull about a parcel, or constellation of stars, that star which falls in the eye will be called the star in the Bull's Eye, or simply the Bull's Eye; another, which respects the tip of one horn, will be named the Bull's Horn; and so of others. A parcel of stars thus contained in any assigned figure is called a constellation. By this means, notwithstanding the seeming impossibility of numbering the fixed stars, their relative situations one to another have been so carefully observed by astronomers, that they have not only been able to number them, but even to distinguish the place of each star in the heavens, and that with greater accuracy than any geographer could ever point out the situations of the several cities or towns upon the surface of the

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earth; and not only the places of those few, if they may be so called, which are to be seen with the naked eye, have been pointed out and registered by them, but even of those which are discovered only by the telescope. The most ancient observations of the stars, which have reached these times, were made by Timocharis and Aristillus, about 300 years before Christ. The next after them, who made a catalogue of the stars visible to the naked eye, and registered their places, was Hipparchus of Rhodes; he flourished about 120 years before Christ, and numbered 1022 stars. After him, Ptolemy enlarged his catalogue to 1026: Ulug Beigh, the grandfather of Tamerlane the Great, about the year 1437, constructed a new catalogue, more exact than that of Ptolemy, containing 1017 stars: Tycho, in the year 1600, determined the places of 777 fixed stars, and reduced them to a catalogue; Kepler's catalogue contained 1163 stars; and that of the Prince of Hesse, 400; Ricciolus enlarged Kepler's catalogue to 1468; and John Bayer, a German, had described the places of 1725 stars; after this, about 1670, Hevelius of Dantzic composed a catalogue of 1888 fixed stars; Dr. Halley also undertook a voyage to the island of St. Helena, in order to take the position of the stars within the antarctic circle, of which he published a catalogue, containing 373 stars; but the largest and most complete catalogue ever yet published, is that of our accurate astronomer, Mr. Flamsteed, in his Celestial History, which contains nearly 3000 stars; all whose places are more exactly determined in the heavens, than the position of cities and other places on the earth.

We ought not, however, to imagine, that all the fixed stars are thus numbered, and reduced to their respective places in the heavens, since their number continually increases, according to the goodness of the telescope, appearing millions beyond millions, till, by their immense distance, they evade the sight, even though assisted by the best instruments. The telescopical stars, with which Mr. Flamsteed has enriched his catalogue, are only the more remarkable ones, whose longitudes and latitudes, or situations in the heavens, it was thought worth while to register and put down. Dr. Hook, with a telescope of twelve feet, saw 78 stars among the Pleiades; and with a longer telescope still more; and, in the single constellation of Orion, which, in Mr. Famsteed's catalogue, has but 80 stars, there have been seen 2000. We may therefore venture to pronounce the number of fixed stars, including the telescopic ones as well as those visible to the naked eye, to be infinitely great, far beyond what it is possible for the best astronomers to calculate, much less to reduce to order. But though the stars are certainly innumerable, yet those visible to the naked eye, in one hemisphere, seldom exceed a thousand; which, perhaps, may appear strange, since, at first sight, their number seems immensely great: but this is only a deception of sight, arising from a confused and transient view; for let a person single out a small portion of the heavens, and, after some attention to the situation of the more remarkable stars therein, begin to count, he will soon be surprised to find how few there are therein. However, even the number of stars visible to the naked eye, small as it is in comparison with that of the telescopic ones, is far from being constant; since, besides that the different states of the atmosphere render many of the lesser stars invisible, some stars have been observed to appear and disappear by turns; particularly one in the chair Cassiopeia, in the year 1572, which for some time outshone the biggest of the fixed stars, and in sixteen months time, by degrees vanished quite away, and was never seen since: in the year 1640, the scholars of Kepler saw a star in the right leg of Serpentarius, which likewise gradually disappeared; Fabricius, in the year 1596, gives the first account of the stella mira, or wonderful star, in the neck of the whale: which has been since found to appear and disappear periodically, its period being seven revolutions in six years, but is never quite extinguished. Several other new stars have been observed: as one by Hevelius, in 1670, and another by Mr. Kircher, in 1689. These new stars are generally observed in the galaxy or milky way. See Galaxy.

As to the causes of this appearing and disappearing of the fixed stars, Sir Isaac Newton conjectures, that as it is possible our sun may sometimes receive an addition of fuel by the falling of a comet into it; so the sudden appearance of some stars, which formerly were not visible to us, may be owing to the falling of a comet upon them, and occasioning an uncommon blaze and splendour for some time; but that such as appear and disappear periodically, and increase by very slow degrees, seldom exceeding the stars

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of the third magnitude, may be such as, having large portions of their surfaces obscured by spots, may, by revolving round their axis like the sun, expose their lighter and darker parts to us successively.

Nature and Distance of the fixed Stars. From the similitude there appears to be between them and the sun, it is generally supposed by philosophers, that they are not placed in the heavens by way of ornament only, or to supply us with a faint light in the absence of the moon; but that each of them is placed in the midst of a system of planetary worlds, and that it directs their motions, and supplies them with light and heat, in the same manner that the sun does the several bodies of which our solar system is composed; in short, that they are so many suns, which no doubt have planets moving regularly round them, though invisible to us. That this is not mere hypothesis, will appear from the following arguments, drawn from the analogy they bear to our sun: The sun shines by its own native light, and so do the fixed stars; the sun, at the distance of the fixed stars, would appear no larger than a star; none of our planets, at that distance, could be seen at all: is it not probable, therefore, that each of the fixed stars is a fixed sun, surrounded by a system of planets and comets, which may be again furnished with different numbers of satellites, or moons, though invisible to us? Besides, as the number of stars is immensely great, dispersed through spaces of the universe far beyond the reach of the best telescopes, and as God has made nothing in vain, it seems highly probable that they severally serve the purposes of light and heat for the planets of their systems; since nothing can be more absurd than to pretend that myriads of unseen stars were made to twinkle in the unknown regions of the universe.

That the fixed stars shine by their own light is thus proved: when viewed through a telescope, they appear only as mere lucid points, destitute of all sensible magnitude, and consequently must be at a vast distance; because the satellites of Jupiter and Saturn, when viewed through a telescope, appear of very distinguishable magnitudes, and yet are invisible to the naked eye. Since, then, the fixed stars are at such a vast distance, that the best telescope has no power to magnify them, and nevertheless shine with a very bright and sparkling light, it is inferred that they must shine with their own proper and unborrowed light; because, if their light was only borrowed, they would, like the satellites already mentioned, be invisible to the naked eye.

The celebrated Huygens found the brightest and largest, and consequently the nearest of the fixed stars, *viz.* Sirius, or the Dog-star, to be in appearance 27,664 times less than the sun; and since the distances of objects are greater as their apparent magnitudes are less, the Dog-star must be distant from our earth, 2,000,000,000,000, or above two millions of millions of English miles; which is so very great, that a cannon-ball, continuing in the same velocity it acquires when immediately discharged at the mouth of the cannon, would spend almost seven hundred thousand years in passing through it; and it is very probable that the fixed stars are equally distant from each other, as the nearest of them is from the sun; since, the better the telescopes we make use of, the more stars are seen. Hence it is very natural to conclude, that all the fixed stars are not placed at equal distances from us; but that they are every where interspersed at great distances beyond one another, throughout the universe; and that, probably, the different appearances which they make, in point of splendour and magnitude, may be rather owing to their various distances from us, than to any real difference in their magnitudes.

From what has been said concerning the number, nature, and distance of the fixed stars, the hypothesis of a plurality of worlds, wherein each fixed star serves as a sun to a system of planets, seems rational, worthy a philosopher, and greatly displays the wisdom, and redounds to the glory of the great Creator and Governor of the universe. Under the article Sun, will be mentioned some of the speculations of Dr. Herschel.

Star, in heraldry, a charge frequently borne on the shield, and the honourable ordinaries, in figure of a star.

Star is also a badge of honour, worn by Knights of the Garter, Bath, and Thistle. See Garter.

Star, in pyrotechny, a composition of combustible matters, which, being thrown aloft in the air, exhibits the appearance of a real star. Stars are chiefly used as appendages to rockets, a number of them being usually inclosed in a conical cap or cover, at the head of the rocket, and carried up with it to its utmost altitude, where the stars, taking fire, are spread around, and exhibit an agreeable spectacle.

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STAR-*board* denotes the right hand side of a ship, when a person on board stands with the face looking forward towards the head or fore part of the ship; in contradistinction from larboard, which denotes the left hand side of the ship in the same circumstances. They say, "starboard the helm," or "helm a starboard," when the man at the helm should put the helm to the right hand side of the ship.

STAR *falling*, or *Shooting Star*, a luminous meteor darting rapidly through the air, and resembling a star falling. The explication of this phenomenon has puzzled all philosophers, till the modern discoveries in electricity have led to the most probable account of it. Signior Beccaria makes it pretty evident that it is an electrical appearance, and recites the following fact in proof of it. About an hour after sunset, he and some friends that were with him observed a falling star directing its course towards them, and apparently growing larger and larger, but it disappeared not far from them, when it left their faces, hands, and clothes, with the earth, and all the neighbouring objects, suddenly illuminated with a diffused and lambent light, not attended with any noise at all. During their surprise at this appearance, a servant informed them that he had seen a light shine suddenly in the garden, and especially upon the streams which he was throwing to water it. All these appearances were evidently electrical; and Beccaria was confirmed in his conjecture, that electricity was the cause of them, by the quantity of electric matter which he had seen gradually advancing towards his kite, which had very much the appearance of a falling star. Sometimes also he saw a kind of glory round the kite, which followed it when it changed its place, but left some light, for a small space of time, in the place it had quitted.

STAR-CHAMBER was a very ancient court, but new modelled afterwards by divers statutes. It consisted of several of the lords, spiritual and temporal, being privy councillors, together with two judges of the courts of common law, without the intervention of any jury. The legal jurisdiction extended over riots, perjury, misbehaviour of public officers, and other notorious misdemeanors. But afterwards they stretched their power beyond the utmost bounds of legality, vindicating all the encroachments of the crown in granting monopolies, in issuing proclamations which should have the force of laws, in punishing small offences, or no offences at all but of their own creating, by exorbitant fines, imprisonment, and corporeal severities; until at last this court became so odious, that it was finally abolished by the 16 Charles I. c. 10. Most of the ancient authorities respecting the law of libels come from this court.

STAR *Fish*. See ASTERIAS.

STARCH. This term is appropriated to a substance existing in vegetables, similar in many of its properties to gum. It is a dry, white powder, which forms the principal part of the nutritive grains and roots. If a paste be formed of wheaten flour and water, and this be washed with additional quantities of water, till it is no longer turbid, but comes off pure and colourless, the mass which remains becomes tenacious and ductile. This is called GLUTEN, which see. If the water with which the paste was washed be allowed to remain at rest, it deposits a white powder, which is distinguished by the name of fecula or starch. Starch is of a fine white colour, and is usually in the state of concrete columnar masses. It has no perceptible smell, and scarcely any taste. It is little altered by exposure to the air; when it is exposed to heat on a hot iron, it melts, swells up, becomes black, and burns with a bright flame. The charcoal which remains contains a little potash. When it is distilled it gives out water mixed with acetic acid, which is contaminated with oil. It gives out also carbonic acid, and carbonated hydrogen gas. Starch is not soluble in cold, but forms a thick paste with boiling water; and when this paste is allowed to cool, it becomes semitransparent and gelatinous; it is brittle when dry, somewhat resembling gum. If this paste be exposed to moist air, it is decomposed, for it acquires an acid taste. Sulphuric acid dissolves starch slowly; sulphurous acid is disengaged, and a great quantity of charcoal is formed. Muriatic acid also dissolves starch, and the solution resembles mucilage of gum Arabic. When left at rest, a thick, oily, mucilaginous liquid appears above, and a transparent straw coloured fluid below. The odour of muriatic acid remains, but when water is added, it is destroyed, and a strong peculiar smell is emitted. Starch is also soluble in nitric acid, with the evolution of nitrous gas. The solution assumes a green colour, and when heat is applied, the starch is converted into oxalic and malic acids. Some part of the starch, however, is insoluble in nitric acid, and, when this is separated by filtration, and

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washed with water, it has a thick, oily appearance like tallow, is soluble in alcohol, and when distilled yields acetic acid, and an oily matter similar to tallow in odour and consistence. Starch is insoluble in alcohol, but is soluble in the alkalies; in pure potash it swells up, becomes transparent and gelatinous, and is then susceptible of solution in alcohol. The component parts of starch, as appears by distilling it, and by the action of re-agents, are, oxygen, hydrogen, and carbon. Starch exists in a great number of vegetable substances, but chiefly in the roots and seeds, and particularly those which are employed as food. Starch, it is well known, may be obtained from the potatoe. If the potatoe be grated down, and washed with water till it comes off pure and colourless, this water, being left at rest, deposits a fine white powder, which assumes something of a crystallized appearance, and is heavier than wheat starch. It is generally mixed or combined with other principles, and sometimes so intimately as not easily to be separated. It is not completely formed, except in certain states of vegetation. In nutritive grains it is perfect only when they have attained maturity, before this it is in a state approaching to mucilage, mixed with saccharine matter.

STARLING. See STURNUS.

STATICE, in botany, *thrift*, a genus of the Pentandria Pentagynia class and order. Natural order of Aggregatæ. Plumbagines, Jussieu. Essential character: calyx one-petalled, entire, plaited, scariose; petals five; seed one, superior. There are thirty-nine species.

STATICS, a term which the modern improvements in knowledge have made it necessary to introduce into physico-mathematical science. It was found convenient to distribute the doctrines of universal mechanics into two classes, which required both a different mode of consideration, and different principles of reasoning. We are indebted to Archimedes for the fundamental principles of this science. He investigated the doctrine of the centre of gravity, and the theory of the lever. But the subject of moving forces was not properly understood, till Galileo considered it very accurately in his work on "Local Motion." In this, he considers a change of motion as the exact and adequate measure of a moving force; and he considers every kind of pressure as competent to the production of such changes. He applied this principle to the motion of bodies by the action of gravity, and gave the theory of projectiles. Sir Isaac Newton took up the subject nearly as Galileo had left it, and applied the doctrines, which had been previously called in aid of mechanics only, to explain the celestial motions; and the magnificence of this subject caused it to occupy the whole attention of mathematicians. The "Principia" contained, indeed, propositions equally conducive to the improvement of common mechanics, and to the complete understanding of the mechanical actions of bodies. Philosophers began to make their applications. They saw that every kind of work that is performed by a machine may be considered abstractedly as a retarding force; that the impulse of water or wind, which are employed as moving powers, act by means of pressures which they exert on the impelled point of the machine; and that the machine itself may be considered as an assemblage of bodies, moveable in certain limited circumstances, with determined directions and proportions of velocity. From these considerations resulted a general abstract condition of a body acted upon by known powers: at length was determined a new kind of equilibrium, not thought of by ancient mechanicians, between the resistance to the machine performing work and the moving power, which exactly balance each other; and is indicated, not by the rest, but by the uniform motion of the machine. Hence also the mathematician was enabled to calculate the precise motion of water which would completely absorb, or balance the superiority of pressure by which water is forced through a sluice, pipe, &c. with a constant velocity.

Thus the general doctrines of motion came to be considered in two points of view, according as they balanced each other in a state of rest, or of uniform motion. These two ways of considering the same subject required both different principles and a different manner of reasoning. The first has been named statics, as expressing that rest which is the test of this kind of equilibrium. The second has been called dynamics, or universal mechanics, because the different kinds of motion are characteristic of the powers or forces which produce them. A knowledge of both is indispensably necessary for acquiring any useful practical knowledge of machines: and it was ignorance of the doctrines of accelerated and retarded motions, which made the progress of practical mechanical knowledge so very slow and

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imperfect. The mechanics, even of the moderns, before Galileo, went no further than to state the proportion of the power and resistance which would be balanced by the intervention of a given machine, or the proportion of the parts of a machine, by which two known forces may balance each other. This view of the matter introduced a principle, which even Galileo considered as a mechanical axiom, *viz.* that what is gained in force, by means of a machine, is exactly compensated by the additional time which it obliges us to employ. This is not quite accurate, and not only prevents improvement in the construction of machines, but leads to erroneous maxims of construction. The two principles of dynamics teach us, that there is a certain proportion of the machine dependent on the kind and proportion of the power and resistance, which enables the machine to perform the greatest possible work. It is highly proper, therefore, to keep separate these two ways of considering machines, that both may be improved to the utmost, and then to blend them together in every practical discussion. Statics, therefore, is preparatory to the proper study of mechanics; but it does not hence derive all its importance. It is the sole foundation of many useful parts of knowledge. This will be best seen by a brief enumeration. 1. It comprehends all the doctrines of the excitement and propagation of pressure, through the parts of solid bodies, by which the energies of machines are produced. A pressure is exerted on the impelled point of a machine, such as the float-boards or buckets of a mill-wheel. This excites a pressure at the pivots of its axle, which act on the points of support. This must be understood, both as to direction and intensity, that it may be effectually resisted. A pressure is also excited at the acting tooth of the cog-wheel, on the same axle by which it urges round another wheel, exerting similar pressures on its pivots, and on the acting tooth perhaps of a third wheel. Thus a pressure is ultimately excited in the working point of the machine, perhaps a wiper, which lifts a heavy stamper, to let it fall again on some matter to be pounded. Now statics teaches us the intensities and direction of all those pressures, and therefore how much remains at the working point of the machine unbalanced by resistance. 2 It comprehends every circumstance which influences the stability of heavy bodies; the investigation and properties of the centre of gravity; the theory of the construction of arches, vaults and domes; the attitudes of animals. 3. The strength of materials, and the principles of construction, so as to make the proper adjustment of strength and strain, in every part of a machine, edifice, or structure of any kind. Statics, therefore, furnishes us with what may be called a theory of carpentry, and gives us proper instructions for framing floors, roofs, centres, &c. 4. Statics comprehends the whole doctrine of the pressure of fluids, whether liquid or æriform, whether arising from their weight, or from any external action. Hence, therefore, we derive our knowledge of the stability of ships, or their power of maintaining themselves in a position nearly upright, in opposition to the action of the wind on their sails. We learn on what circumstances of figure and stowage this quality depends, and what will augment or diminish it. See DYNAMICS, MECHANICS, &c.

STATION, in practical geometry, &c. is a place pitched upon to make an observation, or take an angle, or such like, as in surveying, measuring heights and distances, levelling, &c. An accessible height is taken from one station; but an inaccessible height or distance is only to be taken by making two stations, from two places whose distance asunder is known. In making maps of counties, provinces, &c. stations are fixed upon certain eminences, &c. of the country, and angles taken from thence to the several towns, villages, &c In surveying, the instrument is to be adjusted by the needle, or otherwise, to answer the points of the horizon at every station; the distance from hence to the last station is to be measured, and an angle is to be taken to the next station; which process, repeated, includes the chief practice of surveying.

STATIONARY, in astronomy, signifies the appearance of a planet, when it seems to remain immovable on the same point of the zodiac for several days. As the earth, whence we view the motions of the planets, is out of the centre of their orbits, the planets appear to proceed irregularly; being sometimes seen to go forwards, that is, from west to east, which is called the direction: sometimes to go backwards, or from east to west, which is called the retrogradation. Now between these two states there must be an intermediate one, wherein the planet neither appears to go backwards nor forwards, but to stand still, and keep the same place in her orbit, which is called her station; and this will

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happen when the line that joins the earth's and planet's centre is constantly directed to the same point in the heavens; that is, when it keeps parallel to itself. For all right lines, drawn from any part of the earth's orbit parallel to one another, do all point to the same star; the distance of these lines being insensible, in comparison of that of the fixed stars.

Saturn is seen stationary at the distance of somewhat more than a quadrant from the Sun; Jupiter at the distance of fifty-two degrees; and Mars at a much greater distance. Saturn is stationary eight days, Jupiter four, Mars two, Venus one and a half, and Mercury a half, though the several stations are not always equal.

STATISTICS, a modern term adopted to express a more comprehensive view of the various particulars, constituting the natural and political strength and resources of a country, than was usually embraced by writers on political arithmetic. Its principal objects are, the extent and population of a state; the occupation of the different classes of its inhabitants; the progress of agriculture, of manufactures, and of internal and foreign trade; the income and wealth of the inhabitants, and the proportion drawn from them for the public service by taxation; the condition of the poor; the state of schools, and other institutions of public utility; with every other subject, the knowledge of which tends to establish the true civil policy of the country, and consequently to promote its prosperity.

The great change which has taken place in the business of government, since the introduction of the modern system of warfare, by which the time and labour of a considerable number of persons is wholly appropriated to the profession of arms; and particularly, since the adoption of the borrowing system for defraying the expenses of war has rendered statistical information of much more importance than formerly, the naval and military force which a country is capable of furnishing depending essentially on the state of population and employment, and the public finances becoming, by a continual accumulation of taxes, intimately connected with the state of agriculture, consumption, and foreign trade. Many errors and inconsistencies of former statesmen and legislators might have been avoided by a better knowledge of the state of the country; yet, although the utility of cultivating this branch of knowledge has become so obvious, few of the governments of Europe have appeared much disposed to promote statisical inquiries. It will be a subject of wonder to future times, that even in Great Britain, so late as the year 1800, the state of the population, on which its capability of defence so much depended, was a subject of so much uncertainty, as to be estimated by many persons at but little more than half what it was afterward ascertained to be.

As a comparison of such statistical accounts as have been published of the different states of Europe would be in a great degree useless and unsatisfactory, since the violent and essential alterations most of them have recently undergone, we shall confine ourselves to the principal particulars relative to Great Britain, as deduced from public documents, and other authentic sources.

The island of Great Britain is about 590 miles in length, and the circuit of its coast makes about 1800 miles: the part constituting England and Wales is in length, from Newhaven in Sussex, to Berwick upon Tweed, 355 miles, and in breadth, from the South Foreland in Kent, to the Land's End in Cornwall, 325 miles.

The area of England and Wales, computed in acres, has been very differently stated by different authors; for as it has never been ascertained by an actual survey, various modes of computation have been adopted, which have disagreed materially in the result. The following are the principal estimates on this point.

	Acres.
By Sir William Petty	28,000,000
Dr. Grew . .	46,000,000
Dr. Halley . .	39,938,500
Templeman . .	31,648,000
Arthur Young ..	46,916.000
Rev. H. Beeke .	38,498,572

In the returns relative to the poor, laid before the House of Commons in 1804, it was stated, that by the best computation England and Wales contained 58,335 square statute miles, and 37,334,400 statute acres. Scotland, with its islands, contains about 21,000,000 of acres.

The soil of South Britain is annually cropped nearly in the following proportions.

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STATISTICS.

	Acres.
Wheat	3,080,000
Barley and rye	850,000
Oats and beans	2,800,000
Clover, rye-grass, &c.	1,120,000
Turnips, carrots, cabbages, &c.	1,120,000
Fallow	2,100,000
Hop grounds	35,000
Nursery grounds	8,500
Fruit and kitchen gardens	45,000
Pleasure grounds	16,000
Land depastured by cattle	17,000,000
Hedge-rows, copses, and woods	1,600,000
Ways, water, &c.	1,282,100
Cultivated land	31,056,600
Commons and waste	6,277,800
	37,334,400

The number of horses for which duty is paid is 1,780,000. Their annual consumption of food, reckoned by the produce of acres, is

		Acres each.	Acres.
200,000	pleasure horses	5	1,000,000
30,000	cavalry	5	150,000
1,200,000	husbandry	4	4,800,000
350,000	colts, mares, &c.	3	1,050,000
			7,000,000

The total population of Great Britain, as it appeared by the returns made in 1801, including the army, navy, and merchant seamen, was 10,942,646; to which, if the islands of Guernsey, Jersey, Alderney, and the Scilly islands, are added, it may be taken at 11,000,000. See POPULATION. But it is evident, that the welfare of a nation, and its political strength, do not depend so much on its numerical population, as on the manner in which that population is employed; the proportion of productive to unproductive labourers of which it consists. No accurate account of this kind has ever been taken, but the following estimate of the different classes of persons who compose the present population of Great Britain cannot be far from the truth:

Nobility and gentry	5,000
Clergy of the Churches of England and Scotland	18,000
Ditto dissenters of every description	14,000
Army and militia, including half-pay, &c.	240,000
Navy and marines	130,000
Seamen in the merchant service	155,000
Lightermen, watermen, &c.	3,500
Persons employed in collecting the public revenue	6,000
Judges, counsel, attornies, &c.	14,000
Merchants, brokers, factors, &c.	25,000
Clerks to ditto, and to commercial companies	40,000
Employed in the different manufactures	1,680,000
Mechanics not immediately belonging to ditto	50,000
Shopkeepers	160,000
Scholmasters and mistresses	20,000
Artists	5,000
Players, musicians, &c.	4,000
Employed in Agriculture	2,000,000
Male and female servants	800,000
Gamblers, swindlers, thieves, prostitutes, &c.	150,000
Convicts and prisoners	10,000
Aged and infirm	293,000
Wives and daughters of most of the above	2,427,500
Children under ten years of age	2,750,000
	11,000,000

If these different classes are divided according to the effect produced by their occupations, it will be found that the whole population of the country depends for subsistence, and all the conveniencies of life, on the labour of less than one half of the total number; and the increase or decrease of this productive part of the community, and of the effect of their exertions, is the measure

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of the increase or decline of that gradual accumulation of stock which constitutes national wealth. In a different state of society, however, this division of the population would vary considerably; for were not those, who are considered as unproductive labourers, employed in their several vocations, their duties, or at least the principal of them, must be divided among those who at present are the efficient labourers; who, thus being obliged to give up part of their time to unproductive purposes, could not perform the same quantity of useful labour as at present; and consequently, to support the same population, a greater number of persons would be compelled to engage, at least partially, in productive employs.

The total income of all classes of the community, both as arising from capital and labour, appears to be nearly as follows:

From rent of lands	£. 29,000,000
From rent of houses	8,500,000
Profits of farming, or occupation of land	6,120,000
Income of labourers in agriculture	15,000,000
Profits of mines, canals, collieries, &c.	2,000,000
Profits of merchant shipping and small craft	1,000,000
Income of stockholders	20,500,000
From mortgages and other monies lent	3,000,000
Profits of foreign trade	11,250,000
Profits of manufactures	14,100,000
Pay of army, navy, and merchant seamen	5,000,000
Income of the clergy of all descriptions	2,200,000
Judges and all subordinate officers of the law	1,800,000
Professors, schoolmasters, tutors, &c.	600,000
Retail trades not immediately connected with foreign trade or manufactures	8,000,000
Various other professions and employments	2,000,000
Male and female servants	2,400,000
	£. 132,470,000

If this statement, the total of which is corroborated by the produce of the income or property tax, is not far from the truth, it will not be difficult to form a similar estimate of the total national capital, *viz.*

Value of the land, at 28 years purchase	£. 812,000,000
Value of houses, at 20 years purchase	170,000,000
Manufactories, machinery, steam engines, &c.	20,000,000
Household furniture	42,500,000
Apparel, provisions, fuel, wine, plate, watches, and jewels; books, carriages, and other articles	40,000,000
Cattle of all kinds	90,000,000
Grain of all kinds	10,600,000
Hay, straw, &c.	6,600,000
Implements of husbandry	2,000,000
Merchant shipping	12,800,000
The navy	6,000,000
Coin and bullion	24,000,000
Goods in the hands of merchants, &c.	16,300,000
Goods in the hands of manufacturers, and retail traders	20,000,000
	£ 1,272 800,000

In the year 1795, Mr. Pitt estimated the total landed property at 750 millions, and personal property at 600 millions, making a total of 1350 millions. But even from the above more moderate statement, in which most of the articles are proba-

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bly taken rather below than above the truth, it appears that, notwithstanding all the new wants which refinement and fashion have introduced into the general mode of living, and the expensive wars in which the country has been engaged, there has usually been a surplus of the general revenue, which by gradual accumulation has raised the value of the national stock, or capital, to an amount far exceeding any rational estimate of it at former periods.

It is evident that this statement includes only the real or effective wealth of the country, upon which all other species of wealth, whether consisting in government or private securities, or of any other description, ultimately depend; for private or public loans, in which mode a great part of the property of many persons is invested, are obligations on the part of the borrowers to repay, at a future time, a certain sum in money, which is the measure and representative of all other species of real property, or to pay an income arising from this sum till the capital is repaid. The borrower is no otherwise richer than by the greater income he can make of the money borrowed, than what he agrees to pay for it, as the capital, whether he invests it in land, merchandize, or any other way, remains the property of the lender, who, though he may not by the laws of the country be permitted to take possession of the property into which his money has been converted, may, if necessary, bring it to sale, for the purpose of reconverting it into the equivalent sum which he had lent. If, therefore, the whole national stock was in the hands of one half of the inhabitants, who had borrowed the sum of 1,272,800,000*l.* of the other half, it is evident that it would be the real property, not of those in possession, but of those to whom they were indebted; and this is actually the case with respect to a considerable part of the property of this country, the debts of government having contributed materially to produce this effect.

STATUARY, a branch of sculpture, employed in the making of statues. See SCULPTURE.

Statuary is one of those arts wherein the ancients surpassed the moderns; and indeed it was much more popular, and more cultivated, among the former than the latter. It is disputed between statuary and painting, which of the two is the most difficult and the most artful. Statuary is also used for the artificer who makes statues. Phidias was the greatest statuary among the ancients, and Michael Angelo among the moderns.

STATUES, are figures representing living or deceased creatures, of whatever species, real or imaginary; and carved, cast, modelled, or moulded, in full relievo, insulated on every part. Statues are formed with the chisel, of several materials, such as marble, stone, &c.: they are carved in wood; or cast in plaster of Paris, or other matter of the same nature; they are also cast in several metals, as lead, brass, silver, and gold.

Statues are divided into colossal, or considerably exceeding the dimensions of nature; as, for instance, the celebrated statute of Apollo at Rhodes. Allegorical, or such as, under human or other symbolical forms, represent subjects of a different kind, as Time, Ocean, Winds; or qualities of an intellectual nature, as Mercy, Justice, &c. &c. Statues of deities, demi-gods, and heroes, were among the ancients generally represented somewhat larger than life. Monumental, either representing the person, the virtues, or the actions of the deceased. Equestrian, generally of some illustrious person on horseback. Pedestrian, or on foot. The most celebrated statues are those of the Egyptians, Grecians, and Romans.

STATUES, *antique*. The denomination of antique statues is applicable to all ancient statues, found either in India, Egypt, &c but is especially given, in preference, to the statues wrought by the ancient Greek and Roman sculptors. The works of the Grecians are considered as the most perfect examples of sculpture. Their statues are eminently admirable for the various beauty of their forms, for characteristic expression and grace. The Grecian statues of men are generally naked. The Roman are clothed agreeably to the manner of the country, and are distinguished into palludatæ (statuæ,) those of emperors with long robes over their armour; loricatæ, those of soldiers with cuirasses; thoracatæ, those with coats of armour; togatæ, those of magistrates, with the toga or robe worn in office; trabeatæ, those of senators and augurs; tunicatæ, those clothed with a plain tunic; stolatæ, those of women with long trains.

The antique statues are most particularly remarkable for their systematic representation of the human form. As the principle most apparent in their system is that of proportions, we shall give, first,

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an account of their general proportions to which they chiefly adhered, and next, an accurate measurement of the various parts of the body, taken at Rome, from some of their most celebrated original statues.

"Proportions of the antique Statues." Proportion is the basis of beauty, and there can be no beauty without it; on the contrary, proportion may exist where there is little beauty. Experience teaches us, that knowledge is distinct from taste; and proportion, therefore, which is founded on knowledge, may be strictly observed in any figure, and yet the figure have no pretensions to beauty. The ancients, considering ideal beauty as the most perfect, have frequently employed it in preference to the beauty of nature. It is probable that the Grecian as well as the Egyptian artists determined the great and small proportions by fixed rules; that they established a positive measure for the dimensions of length, breadth, and circumference. This supposition alone can enable us to account for the great conformity which we meet with in ancient statues. Winkelman thinks that the foot was the measure which the ancients used in all their great dimensions, and that it was by the length of it that they regulated the measure of their figures, by giving to them six times that length. This, in fact, is the length which Vitruvius assigns, lib. 3. cap. 1. That celebrated architect thinks the foot is a more determinate measure than the head or the face, the parts from which modern painters and sculptors often take their proportions. This proportion of the foot to the body, which has appeared strange and incomprehensible to the learned Huetius, and has been entirely rejected by Perrault, is, however, founded upon experience. After measuring with great care a vast number of figures, Winkelman found this proportion not only in Egyptian statues, but also in those of Greece. This fact may be determined by an inspection of those statues, the feet of which are perfect; and one may be more fully convinced of it by examining some figures of the Greek divinities, in which the artists have made some parts beyond their natural dimensions. In the Apollo Belvidere, which is a little more than seven heads high, the foot is three Roman inches longer than the head. The head of the Venus de Medicis is very small, and the height of the statue is seven heads and a half; the foot is three inches and a half longer than the head, or precisely the sixth part of the length of the whole statue.

Other writers are of opinion, that the following rules form a principal part of the system of Grecian sculpture: the body consists of three parts, as well as the members. The three parts of the body are, the trunk, the thighs, and the legs. The inferior parts of the body are, the thighs, the legs, and the feet. The arms also consist of three parts. These three parts must bear a certain proportion to the whole, as well as to one another. In a well-formed man, the head and body must be proportioned to the thighs, the legs, and the feet, in the same manner as the thighs are proportioned to the legs and the feet, or the arms to the hands. The face also consists of three parts, that is, three times the length of the nose; but the head is not four times the length of the nose, as some writers have asserted. From the place where the hair begins to the crown of the head are only three-fourths of the length of the nose, or that part is to the nose as nine to twelve.

STATUTE, is a written law, made with the concurrence of the King and both houses of parliament. Divers acts of parliament have attempted to bar, restrain, suspend, qualify, or make void the acts of subsequent parliaments: but this could never be effected; for a latter parliament hath ever power to abrogate, suspend, qualify, or make void the acts of a former, in the whole, or any part thereof, notwithstanding any words of restraint or prohibition in the acts of the former.

When a statute is repealed, all acts done under it, while it was in force, are good; but if it is declared null, all those are void. Where a statute, before perpetual, is continued by an affirmative statute for a time, this does not amount to a repeal of it at the end of that time. When two acts, contradictory to each other, are passed in the same session, the latter only shall take effect. Formerly acts of parliament took effect from the beginning of the session; by a recent statute they have effect from the day on which they are passed.

STATUTES, *construction of*, comprehends the following rules: 1. In the construction of remedial statutes, there are three points which require consideration, *viz.* the old law, the mischief, and the remedy; that is, how the common law stood at the making of the act; what the mischief was, for which the common law did not provide; and what remedy the parliament

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hath provided to cure this mischief. And it is the business of the judge so to construe the act, as to suppress the mischief and advance the remedy. An instance may be specified in the restraining statute of 13 Elizabeth, c. 10. By the common law, ecclesiastical corporations might let as long leases as they thought proper; the mischief was, that they let long and unreasonable leases, to the impoverishment of their successors: the remedy applied by the statute was, the making void all leases by ecclesiastical bodies for longer terms than three lives, or twenty-one years. In the construction of this statute, it is held, that leases, though for a longer term, if made by a bishop, are not void during the bishop's continuance in his see; or, if made by a dean and chapter, they are not void during the continuance of the dean: for the act was made for the benefit and protection of the successor. The mischief is, therefore, sufficiently suppressed, by vacating them after the determination of the interest of the grantors; but the leases, during their continuance, being not within the mischief, are not within the remedy. 2. A statute, which treats of things or persons of an inferior rank, cannot, by any general words, be extended to those of a superior. Thus, a statute treating of "deans, prebendaries, parsons, vicars, and others having spiritual promotion," is held not to extend to bishops, though they have spiritual promotion, deans being the highest persons named, and bishops being of a still higher order. 3. Penal statutes must be construed strictly. Thus, by the statute 14 George II. c. 6, stealing sheep, or other cattle, was made felony, by benefit of clergy: but, or other cattle, being considered as too loose an expression for creating a capital offence, the act was held to extend to nothing but mere sheep. In the next sessions it was therefore found necessary to make another statute, 15 George II. c. 34, extending the former to bulls, cows, oxen, steers, bullocks, heifers, calves, and lambs, by name. 4. Statutes against frauds are to be liberally and beneficially expounded. 5. One part of a statute must be so construed by another, that the whole may (if possible) stand: "ut res magis valeat, quam pereat." As, if land be vested in the king and his heirs by act of parliament, saving the right of A; and A has at that time a lease of it for three years; here A shall hold it for his term of three years, and afterward it shall go to the king. 6. A saving, totally repugnant to the body of the act, is void. If, therefore, an act of parliament vests land in the king and his heirs, saving the right of all persons whomsoever, or vests the land of A in the king, saving the right of A, in either of these cases the saving is totally repugnant to the body of the statute, and (if good) would render the statute of no effect or operation; and therefore the saving is void, and the land vests absolutely in the king. 7. Where the common law and a statute differ, the common law gives place to the statute; and an old statute gives place to a new one: and this upon a general principle of universal law, that "leges posteriores priores contrarias abrogant;" consonant to which it was laid down by a law of the Twelve Tables at Rome, that "quod populus postumum jussit, id jus ratum esto." This is to be understood only when the latter statute is couched in negative terms, or where its matter is so clearly repugnant, that it necessarily implies a negative. But if both acts be merely affirmative, and the substance such that both may stand together, here the latter does not repeal the former, but they shall both have a concurrent efficacy. 8. If a statute, that repeals another, is itself afterwards repealed, the first statute is hereby revived, without any formal words for that purpose. 9. Acts of parliament, derogatory from the power of subsequent parliaments, bind not. 10. Acts of parliament, that are impossible to be performed, are of no validity; and if out of them arise collaterally any absurd consequences, manifestly contradictory to common reason, they are, with regard to those collateral consequences, void. See Blackstone's Commentaries.

Statute *merchant*, and Statute *staple*, are two species of bonds acknowledged upon record before the mayor or clerk of the staple in borough towns, as the case may be; and have the effects of immediate judgments upon the goods, body, and lands of the persons sealing and recording them. They are little used in modern times, but though intended for merchants originally, they may be given by others. Mr. Tidd, in his Practice, (1799,) vol. ii. p. 978, says, that a *capias ad satisfaciendum*, which lies upon common judgments to take the body of the defendant in execution, lies not against peers or members of parliament, except upon a statute merchant or staple. He cites 1 Cromp, 345; and we presume means, that on such a security they may

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be personally taken in execution. If this can be so, it would be well to procure peers and members of parliament to grant such securities; upon which tradesmen might stand an ordinary chance of getting their money.

STAUROLITE, in mineralogy. This stone has been found at Andreasberg, in the Hartz. It is crystallized, and the form of its crystals has induced mineralogists to give it the name of cross stone. Its crystals are two four-sided flattened prisms, terminated by four-sided pyramids, intersecting each other at right angles, the plane of intersection passing longitudinally through the prism. Sometimes these prisms occur solitary. Primitive form, an octahedron with isosceles triangular faces. The faces of the crystals striated longitudinally. Its texture is foliated. Its lustre glassy. Specific gravity 2.3. Colour milk-white. When heated slowly, it loses 0 15 or 0.16 parts of its weight, and falls into powder. It effervesces with borax and microcosmic salt, and is reduced to a greenish opaque mass. With soda it melts into a frothy white enamel. When its powder is thrown on a hot coal, it emits a greenish yellow light. The constituent parts are,

Silica	44
Alumina	20
Barytes	20
Water	16
	100

STAY, in the sea language, a big strong rope fastened to the top of one mast, and to the foot of that next before it, towards the prow, serving to keep it firm, and prevent its falling aftwards, or towards the poop. All masts, top-masts and flag staves, have their stays, except the sprit-sail top-masts. That of the main-mast, is called the main-stay. The main-mast, fore-mast, and those belonging to them have also back-stays, to prevent their pitching forwards, or overboard, as going on either side of her. To stay a ship, or to bring her on the stays, is to manage her tackle and sails so that she cannot make any way forwards; which is done in order to her tacking about.

STEALING, the fraudulent taking away of another man's goods, with an intent to steal them, against, or without, the will of him whose goods they are. This is punished according to circumstances, very differently by the English laws A late statute, 1808, has altered the punishment for privately stealing from the person, or picking pockets, which was a capital felony, and has made it a simple larceny, subject to transportation only. See BURGLARY, LARCENY, ROBBERY.

STEAM *Engine*, an engine for raising water, or for producing any powerful effect in moving machinery, &c. by the force of steam obtained from boiling water. It is often called a fire-engine, on account, perhaps, of the fire employed in heating the water, in order to throw off the steam. This is unquestionably one of the most useful, curious, and important machines that has ever been invented; and it is thought that without the aid of this, or some other engine adapted to the same purpose, we should long ere this have been deprived of the benefit of coal fires; as our forefathers, full a century ago, had excavated almost all the mines of that substance as deep as they could be worked, without the aid of some engine to draw water from greater depths. The principle of this machine is as follows: there is a forcing pump, with its rod fixed to one end of a lever, which is worked by the weight or pressure of the atmosphere upon a piston at the other end, a temporary vacuum being made below it, by suddenly condensing the steam that had been let into the cylinder in which this piston works, by a jet of cold water thrown into it. A partial vacuum being thus made, the weight of the atmosphere presses down the piston, and raises the other end of the straight lever with water, &c. from the mine. Then immediately a hole is uncovered in the bottom of the cylinder, by which a fresh supply of hot steam rushes in from the boiler, which acts as a counterbalance for the atmosphere above the piston, and the weight of the pump rods at the other end of the lever carries that end down, and of course raises the piston of the steam cylinder. The orifice for the emission of the steam is immediately shut, and the cock opened for injecting the cold water into the cylinder: this condenses it to water, and another vacuum is made below the piston, which is now again forced down by the weight of the atmosphere, and thus the work is continued so long as water and fuel are supplied.

This is the common principle of the steam engine, but the methods of operation are very various; there is seldom a

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year that passes away, that we have not new patents obtained for improvements, or professed improvements of this machine. It is comparatively of modern invention: the earliest account of any one is that in the Marquis of Worcester's History of Inventions. published in the year 1663; the description here is too scanty to work upon, but it furnished the idea, which has afforded to ingenious men of all nations the opportunity of putting forth their skill, and their talents, in executing a number of important improvements on the subject. Captain Savery was the first person who attempted to realize the noble Marquis's project: he made the pressure of steam act immediately on the surface of water contained in a close vessel, and the water was forced, by the elasticity of the steam, to ascend through a pipe. The objection to this was, the great heat required for raising water to any considerable height: and also the waste of steam by its coming in contact with the cold water in the receiver, the surfaces of which required to be heated to its own temperature, before the water could be expelled. These inconveniences were in a great measure avoided in Newcomen's engine, where the steam was gradually introduced into a cylinder, and suddenly condensed by a jet of water, so that the piston was forced down with great violence by the pressure of the atmosphere, which produced the effective stroke: this effect was, however, partly employed in raising a counterpoise, which descended, upon the re-admission of the steam, and worked a forcing-pump in its return, when water was to be raised. Engines on this principle were commonly used in this country, till the improvements on them were introduced by Mr. Watt, to whom the public, in this business, is more indebted than to any other person. The engines constructed by this gentleman are said to save three-fourths of the fuel that was used in the best constructed engines of Newcomen, with the waste of only one-fourth of the steam. He has contrived to observe an uniform heat in the cylinder of his engines, by suffering no cold water to touch it, and by protecting it from the air, or other cold bodies, by a surrounding case filled with steam, or with hot air, or water, and by coating it over with substances that conduct the heat very slowly and imperfectly. He makes his vacuum to approach nearly in excellence to that of a barometer, by condensing the steam in a separate vessel, called the condenser, which may be cooled at pleasure, without cooling the cylinder, either by an injection of cold water, or by surrounding the condenser with it. He extracts the injection water and detached air from the cylinder, or condenser, by pumps, which are worked by the engine itself. As the entrance of air into the cylinder would stop, or very much impede, the operation of the engines, and as it is almost impossible to expect such pistons to be absolutely air-tight, a stream of water used to be kept running on the piston, to prevent the entry of the air, as the lighter fluid could not descend through the heavier: this mode, which was not injurious to the engines on the old construction, could not fail to injure the modern ones of Mr. Watt. He therefore makes his pistons more accurately; and the outer cylinder having a lid, which covers it, the steam is introduced above the piston, and when a vacuum is produced under it, acts upon it by its elasticity, as the atmosphere does upon common engines by its gravity. This method of working effectually excludes the air from the inner cylinder, and gives the advantage of adding to the power, by increasing the elasticity of the steam. We shall endeavour to give our readers an idea of the manner in which Mr. Watt's engine works, and then present them with an accurate description, accompanied with engravings of one, to which our draftsman has had access for the purpose.

The cylinder in Mr. Watt's engines is very accurately bored, and surrounded at a small distance with another cylinder furnished with a bottom and lid. The interval between the cylinders communicates with the boilers by a large pipe, open at both ends, so that it is always filled with steam, and thereby keeps the inner cylinder at the same temperature as that of the steam, and prevents any condensation. The inner cylinder has a bottom and piston as usual; and as it does not reach quite up to the lid of the outer cylinder, the steam in the interval has always free access to the upper side of the piston. The lid of the outer cylinder has a hole in its middle; and the piston rod, which is truly cylindrical, moves up and down through that hole, which is kept steam tight by a collar of oakum screwed down upon it. At the bottom of the inner cylinder there are two regulating valves, one of which admits the steam to pass from the interval into the inner cylinder below the piston, or shuts it out at pleasure: the other opens or shuts the end of a pipe, which leads to the conden-

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ser. The condenser consists of one or more pumps, furnished with clacks and buckets, which are worked by chains fastened to the great working beam of the engine. The pipe which comes from the cylinder is joined to the bottom of these pumps, and the whole condenser stands immersed in a cistern of cold water, supplied by the engine. The place of the cistern is either within the house, or under the floor, between the cylinder and the lever wall; or without the house, between that wall and the engine shaft. The condenser being exhausted of air, and both cylinders filled with steam, the regulating valve which admits the steam into the inner cylinder is shut, and the other regulator which communicates with the condenser is opened, and the steam rushes into the vacuum of the condenser with violence: but there it comes into contact with the cold sides of the pumps and pipes, and meets a jet of cold water, which was opened at the same time with the exhaustion regulator: these instantly deprive it of its heat, and reduce it to water; and the vacuum remaining perfect, more steam continues to rush in, and is condensed, till the inner cylinder is exhausted. Then the steam which is above the piston, ceasing to be counteracted by that which was below it, acts upon the piston with its whole elasticity, and forces it to descend to the bottom of the cylinder, and so raises the buckets of the pumps, which are hung to the other end of the beam. The exhaustion regulator is now shut, and the steam one opened again; which, by letting in the steam, allows the piston to be pulled up by the superior weight of the pump rods, and then the engine is ready for another stroke.

The peculiar advantages that result from this construction are, that the cylinder, being surrounded with the steam from the boiler, is kept always uniformly as hot as the steam itself, and is, therefore, incapable of destroying any part of the steam which should fill it: and again, the condenser being kept always as cold as water can be procured, the steam is perfectly condensed, and does not oppose the descent of the piston; which is, therefore, forced down by the full power of the steam from the boiler, which is greater than that of the atmosphere.

A steam-engine of the best construction, with a thirty inch cylinder, acts with the force of 40 horses; and since it acts without intermission, will perform the work of 120 horses, or 600 men; each square inch of the piston being nearly equivalent to a labourer. The consumption of about 84*lbs.* of good pit-coal will raise 48,000 cubical feet of water 10 feet high, which is equivalent to more than the daily labour of eight men: the value of this quantity of coal is seldom so much as that of the work of a single labourer for a day; but the expense of the machinery generally renders a steam-engine somewhat more than half as expensive as the number of horses for which it is substituted. We shall now proceed to a more particular description.

Plates I. and II. Steam Engine, are drawings of a steam-engine of six horses power, built by Mr. John Dixion, Maid Lane, Southwark, and used by him in his steam-engine manufactory, for turning lathes, &c. Plate I. is a general elevation of the whole engine; and Plate II. is a section on a larger scale of the cylinder, steam-pipes, condenser, &c.; *b b*, Plate I. is the cylinder; the internal structure will be described hereafter; *a* is the piston rod connected to the great working beam, B, by a system of levers called a parallel motion, the property of which is, that the rectilinear motion of the piston rod is preserved, though the end of the beam describes an arc of a circle; at the other end of the beam, B, the connecting rod, D, is jointed at its lower end: it is also jointed to the crank, E, upon the axis of the great fly-wheel. When, by the expansive force of the steam, the piston rod, *a*, is caused to ascend, it raises one end of the great beam and depresses the other, and by the connecting rod, D, turns the crank and fly-wheel round. As soon as the piston rod arrives at the top of its stroke, it receives a new impulse, which brings it down again, and consequently raises the connected rod, D, and crank, E. The use of the fly-wheel is to acquire an impetus, at the time when the crank is horizontal, and at which time the connecting rod exerts all the force of the engine upon the crank, to turn it round; this momentum causes the wheel to turn, and the rest of the machinery, when the crank is at the top or bottom of its motion, being then in a line with the connecting rod, it has no tendency to turn it round.

To describe the manner in which the power is given to the piston rod, *a*, we must turn to Plate II. where *b b b b* is the cylinder of cast iron, and truly bored; it is closed at the top by an iron lid, screw-

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ed on by a flanch at the top; in the centre of the lid is a contrivance called a stuffing box, and is for holding a packing of hemp, through which the piston rod, *a a*, passes perfectly air and steam tight, *d d* is the piston packed with hemp, round between its circumference and the inside of the cylinder, so that it can move up and down in the cylinder easily, without allowing any steam to pass by it; the piston is fitted to the rod, *a*, and fast keyed in; the cylinder has a flanch or projecting ring round it, a little below the middle, by which it is held into a jacket, *c c c*, which is constantly supplied with steam from the boiler, A; Plate I. of the engine of the pipe, *e*; *f f*, Plate II. is a pipe, cast at the same time with the cylinder, leading from the top of it, and by a crooked passage to the cock, E; *g g* is another similar passage from the bottom of the cylinder (which is closed, except this pipe has an iron bottom screwed to it) to the cock, and enters the cock diametrically opposite to the other passage; *h* is a passage bringing steam from the jacket, *c c c*; by means of a short pipe not seen in the figure, being behind the cylinder, cast at the same time with the cylinder and joining at the bottom to the flanch, by which the cylinder is screwed into the jacket, *c c c*; the bore of this short pipe is however continued through the flanch, and opens into the jacket, and when they are screwed together, the steam has then free access from the boiler through the jacket into the short pipe, and from thence into the passage, *h*, which goes horizontal towards it; the short pipe has a thin circular vane in it, turning on a pivot across the centre of it, which comes through the pipe, and has a handle on it; by turning this handle, the spindle and vane are turned also; when the vane is set, so that its plane is perpendicular to the axis of the pipe, it nearly fills the circular passage, and allows very little steam to pass by it; but when the vane is turned edgewise, it presents very little surface, and the steam passes by without obstruction to the cock, E; *p p p* is a pipe conveying the steam away from the engine to the condenser, which is an iron cylinder, F F, immersed in cold water contained in a cast iron cistern, G G; the condenser, F F, has a passage from the bottom of it, leading to a pump, H H, called the air-pump, and in which is a valve, *i*, shutting towards the condenser, and preventing any passage from the air-pump to the condenser, though the valve will easily open and allow a passage the other way. The air-pump has a bucket, *k*, sliding up and down in it; the bucket has a hole through it, covered by a valve, *l*, which opens upwards, and prevents the descent of any fluid which may be above it; I is a square iron cistern, screwed on the top of the air-pump, it has a stuffing box in the bottom over the centre of the pump, through which the bucket rod of the air-pump moves freely, yet perfectly air-tight; the bottom of the cistern, I, has also two valves, *m m*, in it, over the air-pump; K is a handle fixed upon a spindle, on which is a rack turning a cog-wheel upon the end of the cock, E; this rack and wheel are taken away in the section, but are plainly seen in Plate I.; L M are two pins fixed upon the rod of the air-pump, and taking the handle, K, as they move up and down, and thus turning the cock, E; *n n* is a lever fixed on the spindle of the handle, K; its ends stop against the ends of a crooked iron, which is screwed to the iron frame, supporting the bearings for the spindle of the rack, so that the motion allowed thereby to the handle, K, and the rack, will turn the cock one-fourth of a whole turn, but no more; N is a cock communicating (when open) from the jacket, *c c*, to the pipe, *p p*, and thereby to the condenser.

The condenser, F F, has a pipe entering it, and turned up within it; the pipe opens to the water in its condensing cistern, G G, and has a cock in its outer end, which regulates the quantity of water the pipe will admit, or closes it entirely; the cock has a long handle coming up out of the water, which is not seen in the section; but is denoted by *o*, in Plate I.

Suppose every thing in the position of the section, the operation of the engine is as follows: when the water in the boiler A, Plate I. is heated by the fire made under it at X, the heat which enters into combination with the water causes it to expand and form steam; in this state it raises and fills the boiler, and thence through the pipe, *e*, enters between the jacket, *c c*, and the cylinder; before the engine can be worked, the steam must be heated, until it is expanded so much, that it will rush forcibly out of the boiler when permitted. The steam also passes through the short pipe, before described, into the passage, *h*, and thence through the crooked passage in the cock, F, to the pipe, *g g*, and the bottom of the cylinder, though it will not enter the cylinder, because it is yet filled with air.

The person who attends the engine

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must now open the cock, N; this admits the steam from the boiler into the condenser; it rushes violently through the pipe, *p p*, into the condenser, F F, driving the air it contained through the three valves, *i*, *l*, and *m*, which it opens, into the cistern, I, (where it is open to the atmosphere, the lid of that cistern being only laid on and not fitting tight:) this operation (called blowing through) continued for a few seconds, expels all the air from the condenser, and fills it with hot steam; the cock, N, is now closed, and the injection cock, of which O, Plate I. is the handle, is opened; this allows a small stream of cold water, from the cistern, G, to enter into the condenser, and condenses the steam, or cools it, and it instantly contracts into the same space it originally occupied when in the boiler, before it was heated. As the valve, *i*, closes, it is evident that a vacuum will be caused in the condenser, as the small quantity of water produced from the steam, and the water injected into the condenser, falling down to the bottom, the air in the upper part of the cylinder will now expand itself into the condenser, through the pipe, *f f*, the cock, E, and pipe *p p*, and as it occupies more space than it did before, it will be considerably rarefied; the stream, pressing with its full force against the lower side of the piston, will, perhaps, (now a rarefaction is made above it,) overcome the resistance of the work and friction, and cause it to ascend, the air-pump rod and bucket moving with it; when the pin, M, upon this rod, reaches the handle, K, it raises it up, and, by means of the rack and wheel shown in Plate I. turns the cock, E, one-fourth of a revolution, bringing its two passages into the position of fig. 2. Plate II.

The operation is now reversed, the steam from the boiler going above the piston, and that steam, mixed with atmospheric air beneath it, going to the condenser, where the steam will be condensed, and a partial vacuum formed beneath the piston; the steam now presses it down, moving the beam flywheel and other machinery it has to drive; when the pin, L, on the air-pump rod arrives at the handle, K, it presses it down, and brings the cock into the position of the figure 1, in which the piston will be driven up again. At each stroke of the engine, when the piston rises, the valve, *i*, on the bucket of the air-pump, will shut, and all the air and water contained above the bucket will be lifted through the valves, *m m*, into the cistern, I; at the same time a vacuum being made beneath the bucket, which is more perfect than that in the condenser, the valve, *i*, will be opened by the water and air in the condenser, which will enter the pump. On the ascent of the piston and the air-pump bucket, the valves, *m m* and *i*, will shut, the pressure which opened them being removed, and the water and air in the pump pressing upon the valve, *l*, will open it, and get through as the bucket descends: at its return, it raises the water and air above it as before. In this manner, when the engine has made a few strokes, all the air contained in the engine at the commencement of the operation will be pumped out: the operation of the engine is now much more perfect. The instant the cock, E, is turned, so as to open a communication from the cylinder full of steam to the condenser, the elasticity of the steam causes it to rush down the pipe, *p p*, into the condenser; when it arrives there, it meets the stream of the injection water, which condenses it, and the remaining steam in the cylinder follows it surprisingly quick, and in an instant an almost perfect vacuum is formed in the cylinder, so that the steam acts with its whole force upon the piston, all resistance upon the other side being removed. The air pump now has only to draw off from the condenser the water injected into it, the condensed steam, and a small quantity of gas, which goes from the boiler with the steam, and will not condense by the cold water; these are delivered by the air pump into the cistern, I, from which the air escapes, the cover not being tight (as before mentioned), the water which still continues hot runs off, when at a certain level, by a waste pipe, *o*, Plate 1. The water which is boiled off in steam from the boiler is renewed from this cistern by means of a small pump, P, Plate I. which draws the water from it by a passage through the centre of the cast iron column, Q, which stands upon the end of the condensing cistern, GG, and supports the bearing for the main axis of the great beam, B; the water is conveyed to the bottom of the column by a short pipe, *r*, and after going through the pump, P, is carried by the pipes, RRR, to a cistern on the top of the vertical pipe, S, which leads into the boiler. The top of S is closed by a valve in the cistern, which is raised by means of a lever, the other end of which has a wire, *y*,

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hooked to it, going through a small stuffing box into a boiler, where it has a stone hung on it; this stone is balanced by a weight hung at the other end of the lever, so that when the stone is covered with water, the weight keeps the valve shut, and prevents any water getting down into the boiler; but as the water sinks in the boiler, the weight of the stone overcomes the weight, and opens the valve; the water in the cistern now runs down the pipe, S, into the boiler, and raises the water and the stone until it closes the valve.

It will easily be seen, that by the condenser being constantly supplied with hot steam, which will give out its heat, and at length render the water surrounding it, in the cistern, G, so hot, that it would condense no more; to prevent this, it is constantly supplied with cold water from a pump, T, worked by a rod from the great beam, B: the water from the cistern runs off by a waste pipe at the back of the cistern, not seen in the figures. V is a short pipe upon the boiler, with a lid and stuffing box; a rod passes through it, and has a valve within it, pressed down by a lever and weight, *v*. If at any time, when the engine is not at work, the steam should be heated, so as to be in any danger of bursting the boiler, the valve will lift up the weight, and allow the steam to escape through the pipe W, into the open air. Y, a lid screwed down upon a hole in the boiler, through which a man enters the boiler to clean it occasionally. At Z are two cocks upon the ends of pipes going down into the boiler; one pipe is longer than the other, the longest reaches into the water, and the short one does not: these cocks are to show the height of the water in the boiler; when one is turned (if the water is the proper height) it will deliver steam, and the other water.

It may be observed, that when the engine is once set to work, the lever *n n*, on the spindle of the rack is of no use, as the instant the cock is turned one-fourth round, the piston and engine begin to return.

STEATITE, in mineralogy, a species of the Talc genus, is of a white colour; but it presents several varieties through the greys, greens, and reds. It occurs massive, disseminated, in crusts, and crystallized. The crystals are six-sided prisms, acuminated on both extremities by six planes. Specific gravity 2.6. The constituent parts are, according to Klaproth,

Silica - - -	48.0
Magnesia - -	20.5
Oxide of iron -	1.0
Water - -	15.5
Alumina - -	14.0
	99.0
Loss -	1.
	100

Before the blow-pipe it loses its colour, and becomes hard; but is infusible without addition It occurs in beds and veins in serpentine, also in regular shaped pieces, imbedded in rocks belonging to the floetz formation. It is found in Norway, Sweden, several parts of Germany, and in the united kingdom of Great Britain; also in China. It is used in the manufacture of porcelain: other varieties are used in fulling, and the Chinese work it into very various shapes.

STEEPLE, an appendage, erected generally on the western end of a church, to hold the bells. Steeples are denominated, from their form, either spires or towers; the first are such as ascend continually, diminishing either conically or pyramidally. The latter are mere parallelopipeds, and are covered a-top platform-like. In each kind there is usually a sort of windows, or apertures, to let out the sound, and so contrived at the same time as to drive it down.

STEERAGE, on board a ship, that part of the ship next below the quarter-deck, before the bulk-head of the great cabin, where the steersman stands in most ships of war. See the next article.

STEERING, in navigation, the directing a vessel from one place to another by means of the helm and rudder. He is held the best steersman who causes the least motion in putting the helm over to and again, and who best keeps the ship from making yaws, that is, from running in and out. The perfection of steering, indeed, consists in a vigilant attention to the motion of a ship's head, so as to check every deviation from the line of her course in the first instant of motion, and in applying as little of the power of the helm as possible. By this she will run more uniformly in a straight path; whereas, if a greater effort of the helm is employed, it will produce a greater declination from the course, increase the difficulty of steering, and make a crooked and irregular track through the water. There are three methods of steering: 1.

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By any mark on the land, so as to keep the ship even by it. 2. By the compass, which is by keeping the ship's head on such a rhumb or point of the compass, as best leads to port. 3. To steer as one is bidden, or conned, which, in a great ship, is the duty of him who is taking his turn at the helm. It is the duty of the steersman to watch the head of the ship, by the land, by clouds, and by the heavenly bodies; because, though the course is in general regulated by the compass, the vibrations of the needle are not so instantly perceived as the sallies of the ship's head to the right or the left.

STELLARIA, in botany, *stichwort*, a genus of the Decandria Trigynia class and order. Natural order of Caryophyllei. Caryophylleæ, Jussieu. Essential character: calyx five-leaved, spreading; petals five, two-parted; capsule superior, one-celled, many-seeded, six-toothed at top. There are seventeen species.

STELLATÆ, in botany, the name of the forty-seventh order in Linnæus's Fragments of a Natural Method, consisting of plants with two naked seeds, and leaves disposed round the stem in the form of a radiant star. In this order are found the Anthospermum, amber tree: Galium, ladies' bedstraw, &c. This order contains herbs, shrubs, and trees. The herbs are chiefly annual, and creep along the surface of the ground: the shrubs and trees are evergreens, which rise erect, and are of an agreeable conic form.

STELLERA, in botany, so named in memory of George Wilh. Steller, adjunct of the Academy at Petersburgh, a genus of the Octandria Monogynia class and order. Natural order of Vepreculæ. Thymeleæ, Jussieu. Essential character: calyx none; corolla four-cleft; stamens very short, nut one, beaked. There are two species, *viz.* S. passerina, flax-leaved Stellera; and S. chamæjasme, Siberian Stellera.

STEM, in botany, that part of a plant arising out of the root, and which sustains the leaves, flowers, fruits, &c.

Stem *of a ship*, that main piece of timber which comes bending from the keel below, where it is scarfed, as they call it; that is, pieced in; and rises compassing right before the forecastle. This stem it is which guides the rake of the ship, and all the but-ends of the planks are fixed into it. This, in the section of a first-rate ship, is called the main-stem.

STEMODIA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx five-parted; corolla two-lipped; stamens four, each filament bifid, two-anthered; capsule two-celled. There are four species.

STEMPLES, in mining, cross-bars of wood in the shafts which are sunk to mines. In many places the way is, to sink a perpendicular hole or shaft, the sides of which they strengthen from top to bottom with wood-work, to prevent the earth from falling in; the transverse pieces of wood used for this purpose, they call stemples, and, by means of these the miners, in some places, descend without using any rope, catching hold of these with their hands and feet.

STERBECKIA, in botany, so named in memory of Francis van Sterbeck, a genus of the Polyandria Monogynia class and order. Natural order of Guttiferæ, Jussieu. Essential character: calyx three or five-leaved; corolla three or five-petalled; capsule corticose, not opening, legume-shaped, many-seeded; seeds imbricate, nestling in pulp. There is only one species, *viz.* S. lateriflora. This is a scandent shrub; leaves sub-opposite, petioled, elliptic, acuminate, quite entire, veined, smooth; peduncles many-flowered, very short, lateral; flowers white and small. It is a native of the woods of Guiana.

STERCULIA, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Tricoccæ. Malvaceæ, Jussieu. Essential character: calyx five-parted; corolla none: nectary bell-shaped, five-toothed, staminiferous, fastened to the column of the germ; germ pedicelled; capsules five, one-celled, opening by the inner side, many-seeded. There are eight species, among which we shall notice the S. balanghas: this is a tall tree, with a stem of two feet in diameter, thick branches, covered with an ash-coloured bark, furnished with alternate, smooth, veined, lanceolate leaves, which are produced only at the upper part of the shoots, and are, in general, about nine inches long and three broad; the flowers are produced in sparse fascicles at the tips of the shoots; the capsules are rather large, smooth, ovate, standing by fives in a stellated direction; each capsule containing six, seven, or eight moderately large round seeds. It is a native of Malabar, Amboyna, &c.

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STEREOGRAPHIC *projection*, is the projection of the circles of the sphere on the plane of some one great circle, the eye being placed in the pole of that circle.

STEREOGRAPHY, the art of drawing the forms and figures of the solids upon a plane.

STEREOMETRY, that part of geometry which teaches how to measure solid bodies, *i. e.* to find the solidity or solid content of bodies, as globes, cylinders, cubes, vessels, ships, &c.

STEREOTYPE *printing*. See PRINTING, *stereotype*. In the beginning of that article an error escaped our notice; for "*by* the Jesuits," read "*say* the Jesuits." We take likewise this opportunity of adding to the article, that though there have unquestionably issued many beautiful specimens of printing from the stereotype press; yet, as the beauty of a book must depend, as well in the stereotype, as in moveable types, on the form and excellence of the letter, it is evident that the same letter from which the stereotype plate is cast, will, in common printing produce as beautiful a page: of this we could adduce many instances; but, perhaps, no person has sent from his office more specimens of this kind than the printer of this dictionary.

STERLING, a term frequent in British commerce. A pound, shilling, or penny, sterling, signifies as much as a pound, shilling, or penny, of lawful money of Great Britain, as settled by authority.

STERN *of a ship*, usually denotes all the hindermost part of her, but properly it is only the outmost part abaft.

STERN *fast*, denotes some fastenings of ropes, &c. behind the stern of a ship, to which a cable, or hawser, may be brought or fixed, in order to hold her stern to a wharf, &c.

STERN *post*, a great timber let into the keel at the stern of a ship, somewhat sloping, into which are fastened the after-planks; and on this post, by its pintle and gudgeons, hangs the rudder.

STERNA, the *tern*, in natural history, a genus of birds of the order Anseres. Generic character: bill straight, pointed, and slender; nostrils linear; tongue slender and pointed; wings very long; back toe small; tail forked. There are twenty-five species. The following are the principal: S. caspia, or the Caspian tern; this abounds on the seas wherein it derives its name. It fishes also in rivers, and sometimes suddenly darts upon its prey from a considerable height, and at other times skims the surface of the water in the manner of a swallow. It is nearly two feet in length. It lays only two eggs, and its sound resembles that of a person laughing.

S. stolida, or the noddy, is a foot and a quarter long, and is frequently met with at sea, between the tropics. It lays its eggs on the bare ground; is considered by navigators as generally indicating the neighbourhood of land; often alights on the yards and rigging of vessels; will suffer itself to be taken by the hand; and from the general want of sagacity which it exhibits, is called by sailors by the name of noddy. It will, however, notwithstanding its alleged tameness and stupidity, often bite with great severity.

S. hirundo, the great tern, is found in various parts of Europe, and in summer on the British coasts. It is fourteen inches long. Its manners, on the water, resemble those of the swallow by land. It skims along precisely in the same manner, catching every insect in its progress; and when it perceives a fish, it darts into the water, and reverts to the air with a rapidity truly astonishing. It is bold and daring; and, in the season of incubation, will attack persons who have given it no molestation, and are at a distance from its nest. For the lesser tern, see Aves, Plate XIII. fig. 7.

STERNOPTYX, in natural history, a genus of fishes of the order Apodes. Generic character: head obtuse; mouth abrupt; teeth very small; no gill-membrane; body compressed, without visible scales; breast carinate, both ways folded, abdomen pellucid. The transparent sternoptyx, the only species under this genus, is between two and three inches long, and is found in the American Seas. Its back rises into a sharp edge. Its general colour is that of a bright silver; but on the back it is somewhat olive-coloured, and its fins and tail are of an obscure yellow; its tail is bifid. See Pisces, Plate VI. fig. 2.

STEW, a small kind of fish-pond, the peculiar office of which is to maintain fish, and keep them in readiness for the daily use of a family, &c. The fish bred in the large ponds are drawn out and put in here. For two large ponds, of three or four acres a-piece, it is advisable to have four stews, each two rods wide, and three long. The stews are usually in gardens, or at least near the house, to be more handy, and the better looked to. The method of making them is, to carry the bottom in a continued decline from one end, with a mouth to favour the drawing with a net.

STEWARD, an officer appointed in

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another's stead or place, and always taken for a principal officer within his jurisdiction Of these there are various kinds. The greatest officer under the crown is the Lord High Steward of England, an office that was anciently the inheritance of the Earls of Leicester, till forfeited, by Simon de Mountford, to King Henry III. But the power of this officer is so very great, that it has not been judged safe to trust it any longer in the hands of a subject, excepting only *pro hac vice*, occasionally: as, to officiate at a coronation, at the arraignment of a nobleman for high treason, or the like. During his office, the Steward bears a white staff in his hand, and the trial, &c ended, he breaks the staff, and with it his commission expires. There is likewise a Lord Steward of the King's household, who is the chief officer of the King's court, has the care of the King's house, and authority over all the officers and servants of the household, except such as belong to the chapel, chamber, and stable.

There is also a steward of the Marshalsea, who has judicial authority. And in most corporations, and all houses of quality in the kingdom, there is an officer of the name and authority of a steward.

The steward of a ship is he who receives all the victuals from the purser, and is to see it well stowed in the hold; all things of that nature belonging to the ship's use are in his custody; he looks after the bread, and distributes out the several messes of victuals in the ship; he hath an apartment for himself in the hold, which is called the steward's room.

STEWART, (the Rev. Dr. Matthew,) in biography, late professor of mathematics in the University of Edinburgh, was the son of the Rev. Mr. Dugald Stewart, minister of Rothsay, in the Isle of Bute, and was born at that place in the year 1717. After having finished his course at the grammar school, being intended by his father for the church, he was sent to the University of Glasgow, and was entered there as a student in 1734. His academical studies were prosecuted with diligence and success; and he was so happy as to be particularly distinguished by the friendship of Dr. Hutcheson, and Dr. Simson, the celebrated geometrician, under whom he made great progress in that science.

Mr. Stewart's views made it necessary for him to attend the lectures in the University of Edinburgh, in 1741; and that his mathematical studies might suffer no interruption, he was introduced by Dr. Simson to Mr. Maclaurin, who was then teaching both the geometry and the philosophy of Newton, and under whom Mr. Stewart made that proficiency which was to be expected from the abilities of such a pupil, directed by those of so great a master. But the modern analysis, even when thus powerfully recommended, was not able to withdraw his attention from the relish of the ancient geometry, which he had imbibed under Dr. Simson. He still kept up a regular correspondence with this gentleman, giving him an account of his progress, and of his discoveries in geometry, which were now both numerous and important, and receiving in return many curious communications with respect to the Loci Plani, and the Porisms of Euclid. Mr. Stewart pursued this latter subject in a different and new direction. In doing so, he was led to the discovery of certain curious and interesting propositions which he published under the title of "General Theorems," in 1746. They were given without the demonstrations; but they did not fail to place their discoverer at once among the geometricians of the first rank. They are, for the most part, Porisms, though Mr. Stewart, careful not to anticipate the discoveries of his friend, gave them only the name of Theorems. They are among the most beautiful, as well as most general propositions, known in the whole compass of geometry, and are perhaps only equalled by the remarkable locus to the circle in the second book of Apollonius, or by the celebrated theorem of Mr. Cotes.

In September, 1747, he was elected professor of mathematics in the University of Edinburgh. The duties of this office gave a turn somewhat different to his mathematical pursuits, and led him to think of the most simple and elegant means of explaining those difficult propositions, which were hitherto only accessible to men deeply versed in the modern analysis. In doing this, he was pursuing the object, which of all others, he most ardently wished to attain, *viz.* the application of geometry to such problems as the algebraic calculus alone had been thought able to resolve. His solution of Kepler's problem was the first specimen of this kind which he gave to the world. This is founded on a general property of curves, which, though very simple, had perhaps never been observed; and by a most ingenious application of that property, he shows how the approximation may be continued to any degree of accuracy, in a series of results which converge with great rapidity.

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This solution appeared in the second volume of the Essays of the Philosophical Society of Edinburgh, for the year 1756. In the first volume of the same collection there are some other propositions of Mr. Stewart's, which are an extension of a curious theorem in the fourth book of Pappus. They have a relation to the subject of Porisms, and one of them forms the ninety-first of Dr. Simson's Restoration.

He next published the "Tracts, Physical and Mathematical." In the first of these, Mr. Stewart lays down the doctrine of centripetal forces, in a series of propositions, demonstrated (if we admit the quadrature of curves) with the utmost rigour, and requiring no previous knowledge of the mathematics, except the elements of plane geometry, and of conic sections. The good order of these propositions, added to the clearness and simplicity of the demonstrations, renders this tract perhaps the best elementary treatise of physical astronomy that is any where to be found.

In the three remaining tracts, our author had it in view to determine the effect of those forces which disturb the motions of a secondary planet. From this he proposed to deduce, not only a theory of the moon, but a determination of the sun's distance from the earth. The former, it is well known, is the most difficult subject to which mathematics have been applied, and the solution required and merited all the clearness and simplicity which our author possessed in so eminent a degree. It must be regretted, therefore, that the decline of Mr. Stewart's health, which began soon after the publication of the tracts, did not permit him to pursue this investigation. The other object of the tracts was, to determine the distance of the sun, from his effect in disturbing the motions of the moon; and his inquiries into the lunar irregularities had furnished him with the means of accomplishing it, as he supposed: and in 1763, he published his "Essay on the Sun's distance," where the computation being actually made, the parallax of the sun was found to be no more than 6″ 9‴, and consequently his distance almost 29,875 semi-diameters of the earth, or nearly 119 millions of miles. A determination of the sun's distance, that so far exceeded all former estimation of it, was received with surprise, and the reasoning on which it was founded was likely to undergo a severe examination. But, even among astronomers, it was not every one who could judge in a matter of such difficult discussion. Accordingly, it was not till above five years after the publication of Dr. Stewart's work, that there appeared a pamphlet, under the title of "Four Propositions," intended to point out certain errors in Dr. Stewart's investigation, which had given a result much greater than the truth. From his desire of simplifying, and of employing only the geometrical method of reasoning, he was reduced to the necessity of rejecting quantities, which were considerable enough to have a great effect on the last result. An error was thus introduced, which, had it not been for certain compensations, would have become immediately obvious, by giving the sun's distance near three times as great as that which has been mentioned.

The "Sun's Distance" was the last work which Dr. Stewart published; and though he lived to see the animadversions made on it, he declined entering into any controversy. His disposition was far from polemical; and he knew the value of that quiet, which a literary man should rarely suffer his antagonists to interrupt. He used to say that the decision of the point in question was now before the public; that if his investigation was right, it would never be overturned; and that if it was wrong, it ought not to be defended.

A few months before he published the Essay just mentioned, he gave to the world another work, entitled, "Propositiones More Veterum Demonstratæ." It consists of a series of geometrical theorems, mostly new; investigated, first by an analysis, and afterwards synthetically demonstrated by an inversion of the same analysis. This method made an important part in the analysis of the ancient geometricians; but few examples of it have been preserved in their writings, and those in the "Propositiones Geometricæ" are therefore the more valuable.

Doctor Stewart's constant use of the geometrical analysis had put him in possession of many valuable propositions, which did not enter into the plan of any of the works that have been enumerated. Of these, not a few have found a place in the writings of Dr. Simson, where they will for ever remain, to mark the friendship of these two mathematicians, and to evince the esteem which Dr. Simson entertained for the abilities of his pupil. Many of these are in the work upon the Porisms, and others in the Conic Sections, *viz.* marked with the letter *a*; also a theorem in the edition of Euclid's Data.

Soon after the publication of the "Sun's Distance," Dr. Stewart's health began to decline, and the duties of his office became burdensome to him. In the year 1772, he retired to the country, where he after-

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wards spent the greater part of his life, and never resumed his labours in the university. He was however so fortunate as to have a son, to whom, though very young, he could commit the care of them with the greatest confidence. Mr. Dugald Stewart, having begun to give lectures for his father from the period above mentioned, was elected joint professor with him in 1775, and gave an early specimen of those abilities, which have not been confined to a single science.

After mathematical studies (on account of the bad state of health into which Dr. Stewart was falling) had ceased to be his business, they continued to be his amusement. The analogy between the circle and hyperbola had been an early object of his admiration. The extensive views which that analogy is continually opening; the alternate appearance and disappearance of resemblance in the midst of so much dissimilitude; make it an object that astonishes the experienced, as well as the young geometrician. To the consideration of this analogy, therefore, the mind of Dr. Stewart very naturally returned, when disengaged from other speculations. His usual success still attended his investigations; and he left among his papers some curious approximations to the areas, both of the circle and hyperbola. For some years, towards the end of his life, his health scarcely allowed him to prosecute study even as an amusement. He died the twenty-third of January, 1785, at sixty-eight years of age. See vol. i. Edinburgh Transactions.

STHENIA, a term employed by the followers of Dr. Brown, to denote that state of the body which disposes to inflammatory diseases, in opposition to those of debility, which arise from asthenia. Dr. Struve in his work on the "Art of prolonging the Life of incurable Persons," gives a few of the theorems after the manner of Brown. He says a stronger stimulus does not, as is commonly believed, destroy a weaker; it only lessens, in a greater or less degree, the force of the latter. Sthenia is always more violent when it is preceded by a considerable asthenia, and *vice versa*. A famished person suddenly filled with food dies apoplectic. Drunkards, if they immediately begin a total abstinence from wine, expose themselves to incurable diseases. Sthenia becomes more violent, in proportion as it alternates more completely with asthenia, that is to say, in proportion as the habit is more frequently exposed at one time to sthenic affections, and at another to asthenic. By this perpetual irritation, the organization becomes so susceptible that it is very liable to suffer in the highest degree from sthenic diseases. This principle is of the greatest importance for practitioners to be aware of, since it proves that a sudden transition from one extreme to another (as, for example, from cold to heat, taking cold liquors when the body is hot, which often destroys the tone and energy of the stomach,) may lay the foundation of an incurable disease, which sometimes remains long concealed, and then shows itself by the most alarming symptoms.

STICK, the same as baton, an instrument of dignity, which is occasionally carried by persons and officers in high situations, particularly by such as are in waiting near the royal person.

STICK, *gold*. An officer of superior rank in the life-guards so called, who is in immediate attendance upon the King's person. When his Majesty gives either of his regiments of life-guards to an officer, he presents him with the gold-stick. The colonels of the two regiments wait alternately, month and month. The one on duty is the called the gold-stick in waiting, and all orders relating to the life-guards are transmitted through him. During that month he commands the brigade, receives all reports, and communicates them to the King. This temporary command of the brigade does not, however, interfere with the promotions that may be going forward, as each colonel lays those of his own particular corps before his Majesty. Formerly the gold-stick commanded all guards about his Majesty's person. On levees and drawing-room days, he goes into the King's closet for the parole.

STICK, *silver*. The field officer of the life-guards, when on duty, is so called. The silver-stick is in waiting for a week, during which period all reports are made through him to the gold-stick; and orders from the gold-stick pass through him to the brigade. In the absence of the gold-stick, on levees and drawing room days, he goes into the King's closet for the parole.

STIGMA, in botany, the summit of the style, the female organ of generation in plants, which receives the fecundating dust of the tops of the stamina, and transmits the effluvia through the style into the heart of the seed-bud, for the purpose of impregnating the seeds. Most plants have a single stigma, but the lilac has two, the bell flower three, and in others there are four and five. The stigma, when single, generally terminates

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the style: when there are several, as in the cotton, and most of the liliaceous plants, they are disposed with admirable symmetry along its sides.

STILAGO, in botany, a genus of the Gynandria Triandria class and order. Essential character: calyx one-leafed, pitcher-shaped: corolla none: female, stigmas sessile; drupe with a two-celled nut. There are two species, *viz.* S. bunius, and S. diandra.

STILBE, in botany, a genus of the Polygamia Dioecia class and order. Generic character: hermaphrodite, calyx exterior; perianth three-leaved; leaflets lanceolate, spreading, and mucronate; interior perianth one-leafed, five-toothed cartilaginous, to be hardened; corolla one-petalled, funnel-form; stamina, filaments four, awl-shaped, placed on the throat, longer; anthers cordate, obtuse pistil, germ superior, ovate; style filiform, length of the stamens; stigma acute; pericarpium none, but the interior calyx inclosing, hardened, deciduous; seed one: male on a distinct individual: calyx exterior, as in the hermaphrodite; interior none; corolla as in the hermaphrodite: the tube membranaceous; stamina as in the hermaphrodite; pericarpium and seed none. There are three species, all natives of the Cape of Good Hope.

STILBITE. This stone was first formed into a distinct species by M. Hauy. Formerly it was considered as a variety of zeolite. The primitive form of its crystals is a rectangular prism, whose bases are rectangles. It crystallizes sometimes in dodecahedrons, consisting of a four-sided prism with hexagonal faces terminated by four-sided summits, whose faces are oblique parallelograms; sometimes in six-sided prisms, two of whose solid angles are wanting, and a small triangular face in their place. Its texture is foliated. The laminæ are easily separated from each other, and are somewhat flexible. Lustre pearly. Hardness inferior to that of zeolite, which scratches stilbite. Specific gravity 2.5. Colour pearl-white. Powder bright-white, sometimes with a shade of red. This powder, when exposed to the air, cakes and adheres, as if it had absorbed water. It causes syrup of violets to assume a green colour. When stilbite is heated in a porcelain crucible, it swells up, and assumes the colour and semi-transparency of baked porcelain. By this process it loses 0.185 of its weight. Before the blow-pipe it froths like borax, and then melts into an opaque white coloured enamel. The constituent parts are,

Silica	52.0
Alumina	17.5
Lime	9.0
Water	18.5
	97.0
	3.0
	100

STILLINGIA, in botany, so named in honour of Benjamin Stillingfleet, a genus of the Monoecia Monadelphia class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: male, calyx hemispherical, many-flowered; corolla tubular, erose: female, calyx one-flowered, inferior; corolla superior; style trifid; capsule tricoccous. There is but one species, *viz.* S. sylvatica; this is a shrub with many upright, round, milky stems, three feet in height, terminated by a spike; two branches commonly spring out at the base of the spike; leaves alternate, petioled, remote, elliptic, serrulate, shining, spreading; spike, or ament, terminating, sessile; flowers small and yellow. It is a native of Carolina, in pine woods.

STIMULI, in botany, *stringe*, a species of armature, or offensive weapon, with which some plants are armed, as the nettle.

STINK *pot*, an earthen jar charged with powder, grenades, and other materials of an offensive and suffocating smell. It is sometimes used by privateers to annoy an enemy when they mean to board.

STINK *stone*, or STINKSTEIN, in mineralogy, a species of the Talc genus, is of a wood-brown colour; it occurs massive, and sometimes disseminated; internally, its lustre is from dull to glimmering; when rubbed it emits an urinous smell; but when exposed to heat it loses its colour and smell, and is converted into quick-lime; it effervesces powerfully with acids. It consists of lime and carbonic acid, and a hydro-sulphuret, which is the cause of the smell which it emits when rubbed: it is found principally in beds. The lightest coloured varieties are the softest.

STIPA, in botany, *feather grass*, a genus of the Triandria Digynia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx two-valved, one-flowered; corolla outer valve with a terminating awn, jointed at the base. There are fourteen species, of which we shall notice the S. pennata, soft feather grass: the root is perenni-

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al, fibrous, and tufted; culms simple, a foot in height, upright, round, smooth, without knots, clothed entirely with the sheaths of the leaves; leaves rolled in, and bristle shaped, mucronate, glaucous; sheaths long and widened; stipule lanceolate, growing to the leaf; panicle simple, few-flowered; flowers large, from four to six; floret awl-shaped, round, nerveless, shorter than the calyx, silky, bristly at the base; the feathered awns are a beautiful and remarkable feature, at once distinguishing this from all other grasses.

STIPULA, in botany, *straw*, one of the fulcra or supports of plants, defined by Linnæus to be a small leaf, stationed on each side the base of the foot-stalks of the flower and leaves, at their first appearance, for the purpose of support. Linnæus considers the stipulæ as essential characters, in discriminating the species; they exhibit the same variety in form and structure as the leaves, at whose insertion they are frequently placed. The greater number of plants have two stipulæ, one on each side of the foot-stalk. Some stipulæ fall before the leaves, as in the cherry; others are permanent, or continue till the fall of the leaves, as in the rose, raspberry, &c. In most plants, the stipulæ are detached from the stalk; but in the rose, raspberry, &c. they grow close to the plant. By means of the stipulæ, we have frequently capital means of distinguishing the species: as an example, the African and Ethiopian species of honey-flower are essentially distinguished from one another, by the number and situation of the stipulæ, which, in the former, are single, and grow to the stalk; in the latter double, and detached from it.

STOCKING, that part of the clothing of the leg and foot which immmediately covers their nudity, and screens them from the cold, &c. Anciently, the only stockings in use were made of cloth, or of milled stuffs sewed together; but since the invention of knitting and weaving stockings of silk, wool, cotton, thread, &c. the use of cloth stockings is quite laid aside. The modern stockings, whether woven or knit, are a kind of plexuses, formed of an infinite number of little knots, called stitches, loops, or meshes, intermingled in one another. Knit stockings are wrought with needles made of polished iron or brass wire, which interweave the threads, and form the meshes the stocking consists of. This operation is called knitting, the invention whereof is commonly attributed to the Scots, on this ground, that the first works of this kind came from thence. It is added, that it was on this account that the company of stocking knitters, established at Paris in 1527, took for their patron St. Fiacre, who is said to have been the son of a king of Scotland. Woven stockings are ordinarily very fine: they are manufactured on a frame, or machine of polished iron.

The English and French have greatly contested the honour of the invention of the stocking-loom; but we are assured whatever pretensions the French claim to this invention, that the same was certainly devised by William Lee, of St. John's College, Cambridge, in the year 1589; though it is true, that he first made it public in France, after despairing of success in his own country.

STOCKS, or *Public Funds in England*. By the word stock was originally meant, a particular sum of money, contributed to the establishing of a fund to enable a company to carry on a certain trade, by means of which the person became a partner in that trade, and received a share of the profit made thereby, in proportion to the money employed. But this term has been extended further, though improperly, to signify any sum of money which has been lent to the government, on condition of receiving a certain interest till the money is repaid, and which makes a part of the national debt. As the security both of the government and of the public companies is esteemed preferable to that of any private person, as the stocks are negotiable; and may be sold at any time, and as the interest is always punctually paid when due; so they are thereby enabled to borrow money on a lower interest than what could be obtained from lending it to private persons, where there must be always some danger of losing both principal and interest. But as every capital stock or fund of a company is raised for a particular purpose, and limited by parliament to a certain sum, it necessarily follows, that when that fund is completed, no stock can be bought of the company; though shares already purchased may be transferred from one person to another. This being the case, there is frequently a great disproportion between the original value of the shares and what is given for them when transferred; for if there are more buyers than sellers, a person, who is indifferent about selling, will not part with his share without a considerable profit to himself: and on the contrary, if many are disposed to sell, and

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few inclined to buy, the value of such shares will naturally fall, in proportion to the impatience of those who want to turn their stock into specie. See FUNDS.

For the sake of those who deal much in the stocks we shall give a Table, showing the comparative value per cent. of the several public funds, and the annual interests produced by 100*l.* invested at different prices.

3 per Cts.	4 per Cts.	5 per Cents.	Bank Stock 7 per ct.	Ind. St. 10 1-2 per Ct.	Annual Interest.
45	60	75	105	157½	6 13 4
45¾	61	76¼	106¾	160¼	6 11 1
46½	62	77½	108½	162¾	6 9 0
47¼	63	78¾	110¼	165⅜	6 6 11
48	64	80	112	168	6 5 0
48¾	65	81¼	113¾	170⅝	6 3 0
49½	66	82½	115½	173¼	6 1 2
50¼	67	83¾	117¼	175⅞	5 19 4
51	68	85	119	178½	5 17 7
51¾	69	86¼	120¾	181⅛	5 15 11
52½	70	87½	122½	183¾	5 14 3
53¼	71	88¾	124¼	186⅜	5 12 8
54	72	90	126	189	5 11 1
54¾	73	91¼	127¾	191⅝	5 9 6
55½	74	92½	129½	194¼	5 8 1
56¼	75	93¾	131¼	196⅞	5 6 7
57	76	95	133	199½	5 5 3
57¾	77	96¼	134¾	202⅛	5 3 10
58½	78	97½	136½	204¾	5 2 6
59¼	79	98¾	138¼	207⅜	5 1 3
60	80	100	140	210	5 0 0
60¾	81	101¼	141¾	212⅝	4 18 9
61½	82	102½	143½	215¼	4 17 6
62¼	83	103¾	145¼	217⅞	4 16 4
63	84	105	147	220½	4 15 2
63¾	85	106¼	148¾	223⅛	4 14 0
64½	86	107½	150½	225¾	4 13 0
65¼	87	108¾	152¼	228⅜	4 11 11
66	88	110	154	231	4 10 10
66¾	89	111¼	155¾	233⅝	4 9 10
67½	90	112½	157½	236¼	4 8 10
68¼	91	113¾	159¼	238⅞	4 7 10
69	92	115	161	241½	4 6 11
69¾	93	116¼	162¼	244⅛	4 6 0
70½	94	117½	164½	246¾	4 5 1
71¼	95	118¾	166¼	249⅜	4 4 2
72	96	120	168	252	4 3 3
72¾	97	121¼	169¾	254⅝	4 2 5
73½	98	122½	171½	257¼	4 1 7
74¼	99	123¾	173¼	259⅞	4 0 9
75	100	125	175	262½	4 0 0

STOCKS, among ship-carpenters, a frame of timber, and great posts made ashore, to build pinnaces, ketches, boats, and such small craft, and sometimes small frigates. Hence we say a ship is on the stocks, when she is a building.

STOCKS, a wooden machine to put the legs of offenders in, for the securing of disorderly persons, and by the way of punishment in divers cases, ordained by statute, &c. And it is said that every ville, within the precinct of a town, is indictable for not having a pair of stocks, and shall forfeit five pounds.

STOEBE, in botany, a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Nucamentaceæ. Corymbiferæ, Jussieu. Essential character: calyx one-flowered; corolla tubular: hermaphrodite, receptacle naked; down feathered. There are nine species, chiefly natives of the Cape of Good Hope; they are shrubby plants, resembling heath; at the Cape it forms the principal food of the rhinoceros.

STOICS, a sect of ancient philosophers, the followers of Zeno, thus called from the Greek στοα, which signifies a porch or portico, in regard Zeno used to teach under a portico or piazza. It was the common fault of the stoics to introduce abundance of subtlety and dryness into their disputations, either by word of mouth, or in writing. They seemed as carefully to avoid all beauty of style, as depravity of morals. Chrysippus, who was one of the stoics, did no great honour to his sect, and could only disgrace it. He believed the gods perishable, and maintained that they would actually perish in the general conflagration He allowed the most notorious and abominable incests, and admitted the community of wives among sages. See ZENO.

STOKESIA, in botany, so named in honour of Jonathan Stokes, M. D. a genus of the Syngenesia Polygamia Æqualis class and order. Essential character: corollets in the ray funnel-form, longer, irregular; down four-bristled; receptacle naked. There is but one species, *viz.* S. cyanea, blue-flowered stokesia. This plant has a corolla resembling that of the common blue bottle, centaurea cyanus, with almost the calyx of carthamus, to which genus it is allied. It is a native of South Carolina.

STOLE, a sacerdotal ornament, worn by the Romish parish-priests over their surplice, as a mark of superiority in their respective churches; and by other priests over the alb, at celebrating of mass, in which

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case it goes across the stomach; and by deacons, over the left shoulder, scarfwise; when the priest reads the gospel for any one, he lays the bottom of his stole on his head. The stole is a broad swathe, or slip of stuff, hanging from the neck to the feet, with three crosses thereon. The bishops anciently pretended, that the parish-priests were never to appear before them but in their stole. In Flanders and Italy they always preach in stoles; it is supposed to be a representation of the extremities of the long robe wore by the high-priest of the Jews.

STOLE, *groom of the*, the eldest gentleman of his Majesty's bed-chamber, whose office and honour it is to present, and put on, his Majesty's first garment, or shirt, every morning, and to order the things in the chamber.

STOLEN *goods*. To help people to stolen goods for reward, without apprehending the felon, is felony. 4 George I. c. 11. Persons having, or receiving, lead, iron, copper, brass, bell metal, or solder, knowing them to be stolen, shall be transported. 29 George II. c. 30.

STOMACH. See ANATOMY.

STOMOXYS, in natural history, a genus of insects of the order Diptera. Sucker with a single valved sheath, inclosing bristles, each in its proper sheath; two feelers, short, setaceous, of five articulations; antennæ setaceous. There are sixteen species, in two sections: A. sheath convolute, and geniculate at the base, with two bristles. B. sheath covering the mouth with five bristles.

STONE (EDMUND), in biography, a distinguished self-taught mathematician, was born in Scotland; but neither the place nor time of his birth is well known; nor have we any memoirs of his life, except a letter from the Chevalier de Ramsay, author of the "Travels of Cyrus," in a letter to Father Castel, a Jesuit at Paris, and published in the "Memoirs de Trevoux," p. 109, as follows: "True genius overcomes all the disadvantages of birth, fortune, and education: of which Mr. Stone is a rare example. Born the son of a gardener of the Duke of Argyle, he arrived at eight years of age before he learned to read. By chance, a servant having taught young Stone the letters of the alphabet, there needed nothing more to discover and expand his genius. He applied himself to study, and he arrived at the knowledge of the most sublime geometry and analysis, without a master, without a conductor, without any other guide but pure genius.

At eighteen years of age he had made these considerable advances without being known, and without knowing himself the prodigies of his acquisitions. The Duke of Argyle, who joined to his military talents a general knowledge of every science that adorns the mind of a man of his rank, walking one day in his garden, saw lying on the grass a Latin copy of Sir Isaac Newton's celebrated "Principia." He called some one to him, to take and carry it back to his library. Our young gardener told him that the book belonged to him. 'To you!' replied the Duke. 'Do you understand geometry, Latin, Newton?' 'I know a little of them,' replied the young man, with an air of simplicity, arising from a profound ignorance of his own knowledge and talents. The Duke was surprised; and having a taste for the sciences, he entered into conversation with the young mathematician: he asked him several questions, and was astonished at the force, the accuracy, and the candour of his answers. 'But how,' said the Duke, 'came you by the knowledge of all these things?' Stone replied, 'A servant taught me, ten years since, to read: does one need to know any thing more than the twenty-four letters, in order to learn every thing else that one wishes?' The Duke's curiosity redoubled; he sat down upon a bank and requested a detail of all his proceedings, in becoming so learned. 'I first learned to read,' says Stone: 'the masons were then at work upon your house: I went near them one day, and I saw that the architect used a rule, compasses, and that he made calculations. I inquired what might be the meaning and use of these things; and I was informed that there was a science called arithmetic: I purchased a book of arithmetic, and I learned it. I was told there was another science called geometry: I bought the books, and I learned geometry. By reading, I found that there were good books in these two sciences in Latin: I bought a dictionary, and I learned Latin. I understood also that there were good books of the same kind in French: I bought a dictionary, and I learned French. And this, my Lord, is what I have done: it seems to me that we may learn every thing, when we know the twenty-four letters of the alphabet.' This account charmed the Duke. He drew this wonderful genius out of his obscurity; and he provided him with an employment which left him plenty of time to apply himself to the

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sciences. He discovered in him also the same genius for music, for painting, for architecture, for all the sciences which depend on calculations and proportions

"I have seen Mr. Stone. He is a man of great simplicity. He is at present sensible of his own knowledge; but he is not puffed up with it. He is possessed with a pure and disinterested love for the mathematics, though he is not solicitous to pass for a mathematician; vanity having no part in the great labour he sustains to excel in that science. He despises fortune also; and he has solicited me twenty times to request the Duke to give him less employment, which may not be worth the half of that he now has, in order to be more retired, and less taken off from his favourite studies. He discovers sometimes, by methods of his own, truths which others have discovered before him. He is charmed to find on these occasions that he is not a first inventor, and that others have made a greater progress than he thought. Far from being a plagiary, he attributes ingenious solutions, which he gives to certain problems, to the hints which he has found in others, although the connection is but very distant," &c.

Mr. Stone was author and translator of several useful works; *viz.* 1. "A new Mathematical Dictionary," in 1 vol. 8vo. first printed in 1726. 2. "Fluxions," in 1 vol. 8vo. 1730. The Direct Method is a translation from the French of Hospital's "Analyse des Infiniments Petits;" and the Inverse Method was supplied by Stone himself. 3. "The Elements of Euclid," in 2 vols. 8vo. 1731. A neat and useful edition of these Elements, with an account of the life and writings of Euclid, and a defence of his Elements against modern objectors: beside other smaller works. Stone was a fellow of the Royal Society, and had inserted in the "Philosophical Transactions" (vol. xli. p. 218.) an "Account of two species of Lines of the third Order, not mentioned by Sir Isaac Newton or Mr. Stirling."

Stone, denotes a certain quantity or weight of some commodities. A stone of beef, at London, is the quantity of eight pounds; in Herefordshire, twelve pounds; in the north, sixteen pounds. A stone of wool (according to the statute of 11 Henry VII.) is to weigh fourteen pounds; yet in some places it is more, in others less; as in Gloucestershire, fifteen pounds; in Herefordshire, twelve pounds. A stone, among horse-coursers, is the weight of fourteen pounds.

STONEHENGE, a celebrated monument of antiquity, stands in the middle of a flat area, near the summit of a hill six miles distant from Salisbury. It is inclosed by a circular double bank and ditch, near thirty feet broad, after crossing which we ascend 30 yards before we reach the work. The whole fabric consisted of two circles and two ovals. The outer circle is about 180 feet diameter; consisting, when entire, of 60 stones, 30 uprights and 30 imposts, of which remain only 24 uprights, 17 standing, and 7 down, 3½ feet asunder, and 8 imposts. Eleven uprights have their 5 imposts on them by the grand entrance. These stones are from 13 to 20 feet high. The lesser circle is somewhat more than 8 feet from the inside of the outer one, and consisted of 40 lesser stones, (the highest 6 feet,) of which only 19 remain, and only 11 standing: the walk between these two circles is 300 feet in circumference. The adytum, or cell, is an oval formed of 10 stones (from 16 to 22 feet high) in pairs, with imposts, which Dr. Stukely calls trilithons, and above 30 feet high, rising in height as as they go round, and each pair separate, and not connected as the outer pair; the highest 8 feet. Within these are 19 more smaller single stones, of which only six are standing. At the upper end of the adytum is the altar, a large slab of blue coarse marble, 20 inches thick, 16 feet long, and 4 broad; pressed down by the weight of the vast stones that have fallen upon it. The whole number of stones, uprights, imposts, and altar, is exactly 140. The stones are far from being artificial, but were most probably brought from those called the Grey Weathers, on Marlborough Downs, 15 or 16 miles off; and if tried with a tool, they appear of the same hardness, grain, and colour, generally reddish. The heads of oxen, deer, and other beasts, have been found on digging in and about Stonehenge; and human bones in the circumjacent barrows. There are three entrances from the plain to this structure, the most considerable of which is from the north-east, and at each of them were raised, on the outside of the trench, two huge stones, with two smaller within, parallel to them.

It has been long a dispute among the learned, by what nation, and for what purpose, these enormous stones were collected and arranged. The first account of this structure we meet with is in Geoffrey of Monmouth, who, in the reign of King Stephen, wrote the history

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of the Britons in Latin. He tells us, that it was erected by the counsel of Merlin, the British enchanter, at the command of Aurelius Ambrosius, the last British King, in memory of 460 Britons, who were murdered by Hengist the Saxon. The next account is that of Polydore Virgil, who says that the Britons erected this as a sepulchral monument of Aurelius Ambrosius. Others suppose it to have been a sepulchral monument of Boadicea, the famous British Queen. Inigo Jones is of opinion that it was a Roman temple, from a stone 16 feet long, and 4 broad, placed in an exact position to the eastward, altar fashion. Mr. Charlton attributed it to the Danes, who were two years masters of Wiltshire; a tin tablet, on which were some unknown characters, supposed to be Punic, was dug up near it in the reign of Henry VIII. but is lost: probably that might have given some information respecting its founders. Its common name, Stonehenge, is Saxon, and signifies a "stone gallows," to which those stones having transverse imposts bear some resemblance. It is also called in Welsh *choir gour*, or "the giant's dance." Mr Grose thinks that Dr. Stukely has completely proved this structure to have been a British temple, in which the Druids officiated. He supposes it to have been the metropolitan temple of Great Britain, and translates the words *choir gour*, "the great choir, or temple."

Stone *ware*, a species of pottery, so called from its hardness. See Delft *ware*, Porcelain, and Pottery. Clay is a principal ingredient in pottery of all kinds, which has the property of hardening in the fire, and of receiving and preserving any form into which it is moulded. One kind of clay resists the most violent action of the fire, after being hardened to a certain degree; but is incapable of receiving a sufficient degree of hardness and solidity. A second kind assumes a hardness resembling that of flint, and such a compactness, that vessels made of it have a glossy appearance in their fracture, resembling porcelain. These two species owe their peculiar properties, of resisting heat without melting, to sand, chalk, gypsum, or ferruginous earth, which they contain. A third species of clay begins to harden with a moderate fire, and melts entirely with a strong fire. It is of the second species that stone ware is made. The most famous manufactory of stone ware, as well as of other kinds of pottery, is at Burslem, in Staffordshire. This can be traced, with certainty, at least two centuries back; but of its first introduction no tradition remains. In 1686, as we learn from Dr. Plot's "Natural History of Staffordshire," published in that year, only the coarse yellow, red, black, and mottled wares were made in this country; and the only materials employed for them appear to have been the different coloured clays which are found in the neighbourhood, and which form some of the measures or strata of the coal mines. These coarse clays made the body of the ware, and the glaze was produced by powdered lead ore, sprinkled on the pieces before firing, with the addition of a little manganese for some particular colours. The quantity of goods manufactured was at that time so inconsiderable, that the chief sale of them, the Doctor says, was "to poor crate-men, who carried them on their backs all over the country." About the year 1690, two ingenious artizans from Germany, of the name of Eller, settled near Burslem, and carried on a small work for a little time. They brought into this country the method of glazing stone ware, by casting salt into the kiln while it is hot, and some other improvements of less importance; but finding they could not keep their secrets to themselves, they left the place rather in disgust. From this time, various kinds of stone ware, glazed by the fumes of salt, in the manner above mentioned, were added to the wares before made. The white kind, which afterwards became, and for many succeeding years continued the staple branch of pottery, is said to have owed its origin to the following accident. A potter, Mr. Astbury, travelling to London, perceived something amiss with one of his horses' eyes; an hostler at Dunstable said he could soon cure him, and for that purpose put a common black flint stone into the fire. The potter observing it, when taken out, to be of a fine white, immediately conceived the idea of improving his ware by the addition of this material to the whitest clay he could procure: accordingly he sent home a quantity of the flint stones of that country, where they are plentiful among the chalk, and by mixing them with tobacco pipe clay, produced a white stone ware, much superior to any that had been seen before. Some of the other potters soon discovered the source of this superiority, and did not fail to follow his example. For a long time they pounded the flint stones in private rooms, by manual labour, in mortars; but many of the poor workmen suffered severely from the dust

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of the flint getting into their lungs, and producing dreadful coughs, consumptions, and other pulmonary disorders. These disasters, and the increased demand for the flint powder, induced them to try to grind it by mills of various constructions; and this method being found both effectual and safe, has continued in practice ever since. With these improvements, in the beginning of the present century, various articles were produced for tea and coffee equipages. Soon after attempts were made to furnish the dinner table also; and, before the middle of the century, utensils for the table were manufactured in quantity, as well for exportation as home consumption. But the salt glaze, the only one then in use for this purpose, is in its own nature so imperfect, and the potters, from an injudicious competition among themselves for cheapness, rather than excellence, had been so inattentive to elegance of form, and neatness of workmanship, that this ware was rejected from the tables of persons of rank; and about the year 1760, a white ware, much more beautiful, and better glazed than ours, began to be imported in considerable quantities from France. This inundation of a foreign manufacture, so much superior to any of our own, must have had very bad effects upon the potteries of this kingdom, if a new one, still more to the public taste, had not appeared soon after. In the year 1763, Mr. Josiah Wedgwood, who had already introduced several improvements into this art, invented a species of earthen ware for the table, quite new in its appearance, covered with a rich and brilliant glaze; bearing sudden alternations of heat and cold, manufactured with ease and expedition, and consequently cheap, and having every requisite for the purpose intended. To this new manufacture the Queen was pleased to give her name and patronage, commanding it to be called Queen's Ware, and honouring the inventor by appointing him her Majesty's potter. The common clay of the country is used for the ordinary sorts; the finer kinds are made of clay from Devonshire and Dorsetshire, chiefly from Biddeford; but the flints from the Thames are all brought rough, by sea, either to Liverpool, or Hull, and so by Burton. There is no conjecture formed of the original reason of fixing the manufacture in this spot, except for the convenience of plenty of coals, which abound under all the country. The flints are first ground in mills, and the clay prepared by breaking, washing, and sifting, and then they are mixed in the requisite proportions. The flints are bought first by the people about the country, and by them burnt and ground, and sold to the manufacturers by the peck. The mixture is then laid in large quantities on kilns, to evaporate the moisture; but this is a nice work, as it must not be too dry; next it is beat with large wooden hammers, and then is in order for throwing, and is moulded into the forms in which it is to remain; this is the most difficult work in the whole manufacture. A boy turns a perpendicular wheel, which, by means of thongs, turns a small horizontal one, just before the thrower, with such velocity, that it twirls round the lump of clay he lays on into any form he directs it with his fingers.

There were many years ago 300 houses, which were calculated to employ, upon an average, 20 hands each, or 6000 in the whole; but of all the variety of people that work in what may be called the preparation for the employment of the immediate manufacturers, the total number is said to be not much short of 15,000, and it is increasing every day. Large quantities are exported to Germany, Ireland, Holland, Russia, Spain, the East Indies, and much to America; some of the finest sorts to France.

STOP, in music, a word applied by violin and violincello performers to that pressure of the strings by which they are brought into contact with the fingerboard, and by which the pitch of the note is determined: a string so pressed is said to be stopped.

Stop, *trumpet*, a reed metallic stop, so called because its tone is imitative of the trumpet. In large organs it generally extends through the whole compass. The mouths of its pipes are not formed like those of the pipes of other stops, but resemble that of the real trumpet. At the bottom of each of the pipes of this stop, in a cavity called the socket, is fixed a brass reed, stopped at the lower end, and open in front; it is furnished with a tongue, or brass spring, which covers the opening, and which, when the wind is impelled into the pipe, is thereby put into a vibratory motion, which produces the imitative tone peculiar to this stop. The trumpet stop is the most powerful in the instrument, and improves the tone as much as it increases the peal of the chorus. Unisonous with the diapasons, it strengthens the foundation, subdues the dissonances of the thirds and fifths of the sesqui-

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altera, and imparts to the compound a richness and grandeur of effect adequate to the sublimest subjects.

STOPPER, in a ship, a piece of cable-laid rope, having a whale-knot at one end, with a laniard fastened to it; and the other end is spliced round a thimble in the ring bolts upon deck, and at the bits: its use is to stop the cable, that it may not run out too fast; in order to which, they make turns with the laniard about the cable, and the whale-knot stops it, so that it cannot slip away faster than is necessary.

STORAX. See Resin.

STORES. If any person, who has the charge or custody of any of the King's armour, ordnance, ammunition, shot, powder, or habiliments of war, or of any victuals for victualling the navy, shall, to hinder his Majesty's service, embezzle, purloin, or convey away the same, to the value of twenty shillings; or shall steal or embezzle any of his Majesty's sails, cordage, or any other of his naval stores, to the value of twenty shillings, he shall be adjudged guilty of felony without benefit of clergy. 22 Charles II. c. 5. The treasurer, comptroller, surveyor, clerk of the acts, or any commissioner of the navy, may act as justices in causing the offender to be apprehended, committed, and prosecuted for the same. 9 George III. c. 30. If any person shall wilfully and maliciously set on fire, burn or destroy any of his Majesty's military, naval, or victualling stores, or other ammunition of war, or any place, where any such stores or ammunition shall be kept; he and his abetters shall be guilty of felony without benefit of clergy. 12 George III. c. 24. None but the contractors with the commissioners of the navy shall make any stores of war, naval stores, with the marks commonly used to his Majesty's stores, upon pain of forfeiting two hundred pounds. And persons, in whose custody such stores shall be found concealed, are liable to the same penalty. Statute 9 and 10 William III. c. 41.

Justices may mitigate the penalty of concealing stores; statute 9 George I. c. 8. Justices of assize and quarter-sessions may hear and determine offences relating to stores; statute 17 George II. c. 40.

STORK. See Ardea.

STOWAGE, in naval affairs, the general disposition of the several materials contained in a ship's hold, with regard to their figure, magnitude, or solidity.

STRAKES, in the sea language, signify the uniform ranges of planks on the bottom, decks, and sides of ships; and the garboard strake is that next the keel.

STRAND, signifies any shore of the sea, or bank of a great river: hence an immunity from paying customs, on goods or vessels, was anciently expressed by strand and stream.

STRANDED, among seamen, is said of a ship that is driven ashore by a tempest, or runs on ground through ill steerage, and so perishes. When any vessel is stranded, the justices of the peace are empowered to command the constables near the sea coast to call assistance, in order to preserve the same, if possible.

STRATA, in natural history, the several beds or layers of different matters whereof the earth is composed. The strata, whereof the earth is composed, are so very different in different countries, that it is impossible to say any thing concerning them, that may be generally applicable: and, indeed, the depths to which we can penetrate are so small, that only a very few can be known to us at any rate; those that lie near the centre, or even a great way from it, being for ever hid. One reason why we cannot penetrate to any great depth is, that as we go down, the air becomes foul, loaded with pernicious vapours, inflammable air, fixed air, &c. which destroy the miners, and there is no possibility of going on. In many places, however, these vapours become pernicious much sooner than in others, particularly where sulphureous minerals abound, as in mines of metal, coal, &c. But, however great differences there may be among the under strata, the upper one is in some respects the same all over the globe, at least in this respect, that it is fit for the support of vegetables, which the others are not, without long exposure to the air. Properly speaking, indeed, the upper stratum of the earth all round is composed of the pure vegetable mould, though in many places it is mixed with large quantities of other strata, as clay, sand, gravel, &c. and hence proceed the differences of soils, so well known to those who practise agriculture. It has been supposed by some naturalists, that the different strata of which the earth is composed were originally formed at the creation, and have continued in a manner immutable ever since: but this cannot possibly have been the case, since we find that many of the strata are strangely intermixed with each other; the bones of animals, both marine and terrestrial, are frequently found at great depths in the earth;

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beds of oyster shells are found of immense extent in several countries; and concerning these and other shell-fish, it is remarkable, that they are generally found much farther from the surface than the bones or teeth either of marine or terrestrial animals.

Neither are the shells or other remains of fish found in those countries adjoining to the seas where they grow naturally, but in the most distant regions. Mr. Whitehurst, in his Inquiry into the Original State and Formation of the Earth, has given an account of many different kinds of animals, whose shells and other remains, or exuviæ, are found in England, though at present the living animals are not to be found, except in the East or West Indies. Nothing has more perplexed those who undertake to form theories of the earth than these appearances. Some have at once boldly asserted, from these and other phenomena, that the world is eternal. Others have had recourse to the universal deluge. Some, among whom is the Count de Buffon, endeavour to prove that the ocean and dry land are perpetually changing places; that for many ages the highest mountains have been covered with water, in-consequence of which the marine animals just mentioned were generated in such vast quantities; that the waters will again cover these mountains, the habitable part of the earth become sea, and the sea become dry land, as before, &c. Others have imagined, that they might be occasioned by volcanoes, earthquakes, &c. which confound the different strata, and often intermix the productions of the sea with those of the dry land.

STRATIOTES, in botany, a genus of the Dioecia Dodecandria class and order. Natural order of Palmæ. Hydrocharides, Jussieu. Essential character: spathe two leaved; perianth superior, trifid; petals three; berry six-celled. There are three species. The stratiotes, water aloe, or water soldier, is a stoloniferous plant, and truly perennial, though each root flowers but once, as in some species of saxifraga, sempervivum, &c. The parent plant, rooted in the mud at the bottom of the ditch, after flowering, sends out buds of leaves at the end of long runners, which rise to the surface, form roots, flower, and then sink to the bottom, where they take hold of the mud, sometimes ripen their seeds, and always become in their turn the parents of another race of young offsets.

STRELITZIA, in botany, so named in honour of Charlotte, Queen of Great Britain, of the family of Mecklenburgh Strelitz, an illustrious patroness of the science of botany, a genus of the Pentandria Monogynia class and order. Natural order of Scitamineæ. Musæ, Jussieu. Essential character: spathes universal and partial; calyx none; corolla three-petalled; nectary three-leaved, involving the gentials; capsule three-celled; cells many-seeded. There are two species, *viz.* S. reginæ, canna-leaved strelitzia, and S. augusta. These plants are natives of the Cape of Good Hope; they were introduced and named by Sir Joseph Banks.

STRENGTH, in physiology, the same with force.

Men may apply their strength several ways in working a machine. A man of ordinary strength, turning a roller by the handle, can act for a whole day against a resistance equal to thirty pounds weight: and if he works ten hours a day, he will raise a weight of thirty pounds through three feet and a half in a second of time: or if the weight be greater, he will raise it so much less in proportion. But a man may act, for a small time, against a resistance of fifty pounds or more. If two men work at a windlass, or roller, they can more easily draw up seventy pounds, than one man can thirty pounds, provided the elbow of one of the handles be at right angles to that of the other. And with a fly, or heavy wheel, applied to it, a man may do one third part more work; and for a little while he can act with a force, or overcome a continual resistance, of eighty pounds: and work a whole day when the resistance is but forty pounds. Men used to bear loads, such as porters, will carry, some one hundred and fifty pounds, others two hundred or two hundred and fifty pounds, according to their strength. A man can draw but about seventy or eighty pounds horizontally: for he can but apply about half his weight. If the weight of a man be one hundred and forty pounds, he can act with no greater force in thrusting horizontally, at the height of his shoulders, than twenty-seven pounds.

As to horses; a horse is, generally speaking, as strong as five men. A horse will carry two hundred and forty, or two hundred and seventy pounds. A horse draws to greatest advantage, when the line of direction is a little elevated above the horizon, and the power acts against his breast: and he can draw two hundred pounds for eight hours a day, at two miles

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and a half an hour. If he draw two hundred and forty pounds, he can work but six hours, and not go quite so fast. And in both cases, if he carries some weight, he will draw the better for it, and this is the weight a horse is supposed to be able to draw over a pulley out of a well. But in a cart a horse may draw one thousand pounds, or even double that weight, or a ton weight, or more. As the most force a horse can exert is when he draws a little above the horizontal position, so the worst way of applying the strength of a horse is, to make him carry or draw up hill: and three men on a steep hill, carrying each one hundred pounds, will climb up faster than a horse with three hundred pounds. Also, though a horse may draw in a round walk of eighteen feet diameter; yet such a walk should not be less than twenty-five or thirty feet diameter.

STREPTIUM, in botany, a genus of the Didynamia Angiospermia class and order. Essential character: calyx five-toothed; stigma two lipped; drupe two-lobed, each lobe bipartite. There is but one species, *viz.* S. asperum; this plant has a woody, perennial, short, irregular stem: branches opposite, exactly four-sided, rough: the height of the whole plant is from two to four feet: leaves opposite, petioled, covered with stiff hooked hairs, from one to three inches long, and from one to two broad; raceme terminating, or in the cleft of the exterior branchlets, erect, long; rachis four-seeded, rough; bractes solitary, one flowered. Flowers towards the bottom of the raceme, remote; above approximated, small, white. This plant was found by Dr. Roxburgh only in the vicinity of Samulcottah, on the terraces of the old walls of pagodas. It flowers during the wet and cold seasons; when young, it is a fair looking plant. The Telingas call it obeera.

STRIKE, a measure of capacity, containing four bushels.

Strike, among seamen, is a word variously used: when a ship in a fight, or on meeting with a ship of war, lets down, or lowers her top sails, at least half-mast high, they say she strikes, meaning she yields or submits, or pays respect to the ship of war. Also, when a ship touches ground, in shoal water, they say she strikes. And when a top-mast is to be taken down, the word of command is, strike the top-mast, &c.

STRIX, the *owl*, in natural history, a genus of birds of the order Accipitres. Generic character: the bill hooked, but not furnished with a cere; nostrils oblong, covered with bristly feathers; head, eyes, and ears particularly large; tongue bifid; claws hooked and sharp. Birds of this genus are rapacious. They are seldom seen by day, secluding themselves in the hollows of trees and buildings, and unable, from the particular structure of the eye, to endure the glare of sunshine. When they do appear in the day, they are pursued and persecuted by a variety of small birds, who combine in their expressions of ridicule and aversion, and soon oblige them to recur again to their retreat. During the season of general repose, they are active in quest of food, which in darkness they perceive with facility, and disturb the silence of night by loud and reiterated screams. Their usual prey consists of bats, mice, and small birds. Latham enumerates forty, and Gmelin fifty species. The following are the principal:

S. bubo, or the great-eared owl, is nearly of the size of an eagle, and generally inhabits sequestered and mountainous situations, and the clefts and caverns of rocks, rarely perching upon trees, or seen in the plains. Its nest is nearly three feet in diameter, and its young are seldom more than two, for which it provides extreme plenty and variety It lives on rats, frogs, and snakes, which it swallows entire, and leverets and rabbits, which it tears to pieces. The hair is thrown up in small balls from the stomach, and many of these may be seen in the places of its favourite residence. It is very rare in England. In Italy it has been trained in the manner of the hawk.

S. otus, or the long-eared owl, is fourteen-inches long, and is common both in France and England. It haunts mountainous districts and ruined buildings, and rarely builds a nest, generally occupying that of the buzzard or magpie.

S. brachyotus, or the short-eared owl, is about the size of the last, and is distinguished by the smallness of its upright tufts, or ears, which after its death, are scarcely perceivable, and when the bird is frighted, are considerably depressed; but when it is at ease, are clearly perceivable, and in an erect state. Its colour is of a dark brown. It is one of the most beautiful or least disgusting, of the genus; it is often seen in small companies, and sometimes in a flock of more than twenty, and lives chiefly on mice, which it watches with all the acuteness and perseverance of a domestic cat.

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S. flammea, or the white owl, is fourteen inches long, and is frequently observable in ruined and deserted buildings, though in towns of great population and extent. These it quits by night in search of prey, consisting of mice and birds. It is denominated the screech owl, from the utterance of a screaming and terrific noise, which is peculiar to it, and is distinguished also by a snoring sound during its sleep.

S. passerina, or the little owl, is sometimes found in France, and is seldom met with in woods, preferring rocks and decayed buildings. It is distinguished by its activity and clear sightedness during the day, in which it will follow swallows in chase, though rarely, if ever with success. Small birds in general constitute part of its food, and rats and mice form its principal dependence, but are necessarily torn to pieces by it, as its size is small, and its length does not exceed eight inches.

STROBILUS, in botany, signifies a cone, a species of seed vessel composed of woody scales, which are placed against one another, and split only at top, being fixed below to an axis which occupies the centre of the cone. This botanical term is exemplified in the pine, cypress, fir, and other cone-bearing plants.

STROMATEUS, the *stromat*, in natural history, a genus of fishes of the order Apodes. Generic character: head compressed; teeth in the palate as well as jaws: body oval, broad and slippery; tail forked. There are three species. S. fixtola, or striped stromat, is an inhabitant of the Mediterranean. Its colour, on the upper parts, is blue, and that of the sides and abdomen of a brilliant silver colour, and its body is transversely marked by serpentine lines of gold; its lips are red, and two lateral lines appear on each side of the back, that nearest the top being curved.

The paru stromat is about as large as a turbot, and is found in the American seas, is of a bright gold colour on the upper, and silver on the lower parts of its body. It is in high estimation for the table.

The ash-coloured stromat is of the length of a foot, inhabits the Indian seas, and is valued as a high delicacy. Its bones are little more than cartilages. The largest fishes of this species are generally deemed the best.

STRONTITES, or Strontian, in mineralogy, is of a green colour; it occurs sometimes massive, and sometimes crystallized. This earth was not discovered till about the year 1791 or 1792. Dr. Crawford, indeed, previously to this period, in making some experiments on what he supposed was a carbonate of barytes, and observing a striking difference between this mineral and the carbonate of barytes which he had been accustomed to employ, conjectured that it might contain a new earth; and he sent a specimen to Mr. Kirwan for the purpose of analyzing it. This conjecture was fully verified by the experiment of Dr. Hope, Mr. Kirwan, and M. Klaproth, who were all engaged in the same analysis nearly about the same time. This earth is found native in combination with carbonic and sulphuric acids. With the former it is found in considerable quantity in the lead mines of Strontian in Argyleshire, from which it has derived its name, strontites, or strontian, as it is called by others; here it occurs with lead glance, heavy spar, &c. The nature and properties of this earth have been still further investigated by Pelletier, Fourcroy, and Vauquelin. This earth may be obtained in a state of purity, either by exposing the carbonate of strontites mixed with charcoal powder to a strong heat, by which the carbonic acid is driven off; or by dissolving the native salt in nitric acid, and decomposing the nitrate of strontites thus formed by heat. Strontites, obtained by either of these processes, is in small porous fragments of a greenish white colour. It has an acrid, hot, alkaline taste, and converts vegetable blues to green. The specific gravity is from 3.4 to 3.6. Light has no perceptible action upon this earth. When it is exposed to heat it may be kept a long time even in a red heat, without undergoing any change, or even the appearance of fusion. By the action of the blowpipe it is not melted, but is surrounded with a very brilliant white flame. When a little water is thrown on strontites, it exhibits the same appearance as barytes. It is slaked, gives out heat, and then falls to powder. If a greater quantity of water be added, it is dissolved. According to Klaproth, it requires 200 parts of water, at the ordinary temperature of the atmosphere, for its solution. Boiling water dissolves it in greater quantity, and when the solution cools, it affords transparent crystals. These crystals are in the form of rhomboidal plates, or in that of flattened silky needles, or compressed prisms. They effloresce in the air, and have an acrid hot taste. The solution of this earth in water is acrid and alkaline, and

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converts vegetable blues to green. It is soon covered with a pellicle, by absorbing carbonic acid from the atmosphere. Strontites has the property of communicating a purple or red carmine colour to flame. Specimens have been analyzed by various chemists, who have obtained different results; according to Klaproth, the constituent parts are,

Strontites	69 5
Carbonic acid . . .	30.0
Water	5
	100

STRONGILUS, in natural history, a genus of the Vermes Intestina class and order. Body round, long, pellucid, glabrous; the fore part globular, truncate, with a circular aperture fringed at the margin; the hind part of the female entire and pointed; of the male dilated into loose, distant, pellucid membranes. There are two species, *viz.* S. equinus, and S. ovinus; the latter is found in the intestines of sheep; the former has an opaque head and a black intestine; it inhabits the stomach of the horse in great numbers; the male is of a pale yellow, with a fine yellowish membrane covering the intestines; the tail is three-leaved, with a small spine or two; female with white filiform vesicles surrounding the intestines.

STROP, in naval affairs, a piece of rope, spliced generally into a circular wreath, and used to surround the body of a block, so that the latter may be hung to any particular situation about the masts, yards, or rigging. Strops are also used to fasten upon any large rope, for the purpose of hooking a tackle to the eye of the strop, in order to extend, or pull with redoubled effort upon the same rope.

STROPHE, in ancient poetry, a certain number of verses, including a perfect sense, and making the first part of an ode. What the couplet is in songs, and the stanza in epic poetry, the strophe is in odes.

STRUMPFIA, in botany, so named in memory of Christopher Car. Strumpff, professor of chemistry and botany at Halle in Madgeburgh, a genus of the Syngenesia Monogynia class and order. Natural order of Compositæ Numentaceæ. Essential character: calyx five-toothed, superior; corolla five-petalled; berry one-seeded. There is only one species, *viz.* S. maritima. It is a native of Curacoa, on rocks by the coast.

STRUTHIO, the *ostrich*, in natural history, a genus of birds of the order Gallinæ. Generic character: the bill straight, depressed like that of a duck, and rounded at the end; wings short, and unfit for flight; legs naked above the knee; two toes placed forward. Gmelin enumerates four species of this genus, several of which have characters not a little dissimilar in some points, and such as have induced Brisson and Latham to adopt a different arrangement. Having noticed this circumstance, we shall adhere to the Linnæan system. S. camelus, or the black ostrich, is about eight feet long, and when erect measures about seven feet, and sometimes eight in height. One was exhibited in London in 1750, weighing three hundred pounds. It is found in various parts of Africa, and about the Cape of Good Hope is particularly abundant. In the parts of Asia, near Africa, it is also met with. The idea of these birds burying their eggs in the sand, where the sun brings them to maturity, is contradicted by Kolben, who states that he has driven the ostrich from its nest innumerable times to procure its eggs for food, adding, that these constitute a most excellent repast, and that one is sufficient for four moderate persons. The ostrich subsists entirely on vegetable productions, but will swallow, occasionally, the most hard and even sharp and pointed substances. Iron, and various other metals, and even glass, have often been found in its stomach, and have unquestionably often proved fatal. It is related, upon respectable authority, that an ostrich will carry a man upon its back, and move with very considerable speed; some make the same remark with respect to two men. When unincumbered by any burden its speed is truly extraordinary, and will exceed, in some instances, the ordinary rapidity of a horse. Ostriches are taken by the natives near the Cape, after a pursuit of two or three days, from mere exhaustion, through which they suffer themselves to be destroyed merely by clubs. Dogs are sometimes employed to hunt them down, followed by men on horseback, who contrive, by means of a long hooked staff, to lay hold of one of the legs of the bird, and thus bring it to the ground. Sometimes they are approached and destroyed by the stratagem of advancing against them in one of the skins of their own species. They are applied to various purposes. Their feathers form an admirable orna-

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ment for the ladies: their skins are of sufficient thickness to be manufactured for the purposes of leather; the fat part of their bodies is in high, but perhaps fanciful, estimation in many parts for paralytic and rheumatic complaints; even their eggs are used as goblets, and, if some authors may be credited, young ostriches constitute an agreeable variety for the table. See Aves, Plate XIV. fig. 1.

S. casuarius, or the galeated cassowary, is nearly equal in magnitude to the ostrich, but has a much shorter neck, and therefore is greatly inferior in height. On the top of its head is a species of helmet three inches high, and one thick at the base. Each wing, or what appears as such, is destitute of feathers, and has five bare shafts like those of a porcupine, and the body is covered with loose webbed feathers of a rusty black colour. It is never found beyond the tropical limits, and is no where abundant within them. It is unable to fly, but runs with great speed; and though it lives only on vegetables and fruits, which it is said to swallow unbroken, it is courageous, and even sometimes ferocious, and employs its legs to annoy its adversary by kicking.

S. Nova Hollandia, or the New Holland cassowary, is very similar to the above, but considerably longer.

S. rhea, or the American ostrich, is stated to have been seen by various travellers, but no specimen appears to have been received in this country. It is said to be most numerous in the valleys of the Andes. It subsists partly on fruits, but refuses scarcely any thing that is thrown to it, however inconvenient and pernicious to it. Its favourite food consists of flies, in taking which, it is peculiarly active and skilful. Each of its eggs is supposed to contain two pounds of fluid, and it lays between fifty and sixty of these. It calls its young ones by a sound extremely resembling the whistle of a human being, and defends itself by kicking. Its feathers are in high estimation among the Indians for the embellishment of their persons, and are used in forming ornamental coverings for shade.

STRUTHIOLA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Vepreeuculæ. Thymeleæ, Jussieu. Essential character: corolla none; calyx tubular, with eight glands at the mouth; berry juiceless, one-seeded. There are five species, all natives of the southern promontory of Africa.

STRYCHNOS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Apocineæ, Jussieu. Essential character: corolla five-parted; berry one-celled, with a woody rind. There are three species: we shall notice the S. nux vomica, poison nut. It is a native of the East Indies, and is common in almost every part of the coast of Coromandel, flowering during the cold season. The wood is hard and durable, and is used for many purposes by the natives. The root is used to cure intermitting fevers, and the bites of venomous snakes. The seed of the fruit is the officinal nux vomica; it is about an inch broad, and nearly a quarter of an inch thick, covered with a kind of woolly matter; internally it is tough and hard, like horn; to the taste extremely bitter, but having no remarkable smell; it consists chiefly of a gummy matter; the resinous part is very inconsiderable. Nux vomica is reckoned amongst the most powerful poisons of the narcotic kind; it proves fatal to dogs in a very short time. Loureiro relates, that a horse died within a quarter of an hour, after taking an infusion in wine of the seeds in an half roasted state.

STUARTIA, in botany, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Tiliaceæ, Jussieu. Essential character: calyx simple; style simple, with a five-cleft stigma; pome juiceless, fibe-lobed, one-seeded, opening five ways. There are two species, *viz.* S. malacodendron; and S. pentagynia; both natives of Virginia.

STUDDING *sails*, are those which are extended in moderate and steady breezes beyond the skirts of the principal sails, where they appear as wings to the yard-arms.

STURNUS, the *stare* or *starling*, in natural history, a genus of birds of the order Passeres. Generic character: the bill straight and depressed; nostrils surrounded and protected by a prominent rim; tongue hard and cloven; middle toe joined to the outermost, as far as the first joint. There are seventeen species, of which we shall notice the following:

S. vulgaris, the common starling, weighs about three ounces, and is well known nearly throughout the old world. It builds in rocks, houses, and the hollows of the trunks of trees; but rarely on the branches, unless when availing itself of the deserted nest of some other bird. In winter, starlings are seen in immense

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multitudes, in company with several other British birds, especially fieldfares and redwings; and their flight is particularly marked by whirling and nearly circular movements, which, while they extremely delay their actual progress, do not absolutely prevent it. They assemble in the mornings to make their excursions for food, which consists of worms and insects, returning to their stations in the evening, and, at both seasons, exhibiting extraordinary tumult and clamour. In confinement, they eat with avidity pieces of raw meat; and, in a state of nature, they are supposed to prefer animal food to vegetable, recurring to the last only when the former is not to be found. They are extremely docile and mimetic, and may be taught not merely a great variety of sounds, but even words and phrases.

STYLE, a word of various significations, originally deduced from a kind of bodkin, wherewith the ancients wrote on plates of lead, or on wax, &c. and which is still used to write on ivory leaves, and paper prepared for that purpose, &c.

STYLE, in dialling, denotes the gnomon or cock of a dial, raised on the plane thereof, to project a shadow.

STYLE, in botany, is a part of the pistil of plants, and is of various figures, but always placed on the germen: it gives origin to the stigma.

STYLE, in matters of language, a particular manner of expressing one's thoughts agreeably to the rules of syntax; or, the manner wherein the words, constructed according to the laws of syntax, are arranged among themselves, suitably to the genius of the language.

STYLEPHORUS, in natural history, a genus of fishes of the order Apodes. Generic character: eyes pedunculated, standing on a short, thick cylinder; snout lengthened, directed upwards, retractile towards the head, by means of a membrane; mouth without teeth; three pair of branchiæ beneath the throat: pectoral fins small; dorsal extending completely along the back: caudal short, with spiny rays; body very long and compressed. There is only one species of this wonderful genus, which was first described towards the close of the last century.

S. chordatus is a native of the West India seas, and is nearly three feet in length, including the process at the end of the tail, which is about twenty inches. For a minute description of this singular animal, which was taken swimming near the surface of the water, between Cuba and Martinique, the "Linnæan Transactions," or "Naturalist's Miscellany," may be consulted with satisfaction.

STYLUS, in botany, the slender part of the pistillum, resembling a pillar, which stands upon the seed-bud, and elevates the stigma. The number of styles, generally speaking, is equal to that of the seed-buds, each seed-bud being furnished with its own particular style. The style either falls with the other parts of the flower, or accompanies the fruit to maturity.

STYPTIC, in pharmacy, medicines which, by their astringent qualities, stop hæmorrhages.

STYRAX, in botany, *storax*, a genus of the Decandria Monogynia class and order. Natural order of Bicornes. Guaiacanæ, Jussieu. Essential character: calyx inferior; corolla funnel-form; drupe two-seeded. There are four species, the most remarkable of which is the S. benzoin, benzoin storax, or benjamin tree, as it is corruptly called, is of quick growth, rising to a considerable height: it is deemed, in Sumatra, which is its native country, to be of sufficient age in six years, or when the trunk is about seven or eight inches in diameter, to afford the benzoin; the bark is then cut through longitudinally, at the beginning of the principal lower branches, from which the drug exudes in a liquid state, and by exposure to the sun and air soon concretes, when it is scraped off from the bark with a knife or chissel. The quantity which one tree affords never exceeds three pounds; nor are the trees found to sustain the effects of these annual incisions longer than ten or twelve years. The benzoin which issues first from the wounded bark is the purest, being soft, extremely fragrant, and very white; that which is less esteemed is of a brownish colour, hard, and mixed with various impurities. In Arabia, Persia, and other parts of the east, the coarser sort is consumed in fumigating and perfuming the temples, and in destroying insects.

SUBALTERN, a subordinate officer, or one who discharges his post under the command, and subject to the direction, of another: such are lieutenants, sub-lieutenants, cornets, and ensigns, who serve under the captain; but custom has now appropriated the term to those of much lower rank, as serjeants and the like. We also say subaltern courts, jurisdictions, &c. such are those of inferior lords, with regard to the lord paramount; hundred courts, with regard to county courts, &c.

SUBCONTRARY *position*, in geometry is when two similar triangles are so placed

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as to have one common angle at the vertex, and yet their bases not parallel.

SUBDUPLE *ratio*, is when any number or quantity is contained in another twice: thus 3 is said to be subduple of 6, as 6 is duple of 3.

SUBDUPLICATE *ratio*, of any two quantities, is the ratio of their square roots. This is the opposite to the duplicate, which is the ratio of the squares: thus, if the quantities be a and b, the duplicate ratio is $a^2 : b^2$; but the subduplicate ratio is $\sqrt{a} : \sqrt{b}$.

SUBER, or SUBERIC *acid*, in chemistry. The vegetable substance denoted by the name of suber is the epidermis, or outer covering of trees. This substance is analogous to common cork, which is the epidermis of the quercus suber, from which the name of this peculiar vegetable substance is derived. It is a light, soft, elastic substance, is insoluble in water, but readily absorbs this liquid. Common cork is the same substance, having greater density, and accumulated in greater quantity. This matter is very combustible, and burns with a white, vivid flame, leaving behind a very black, light, voluminous, coaly matter. When this matter is distilled, it yields ammonia. When cork is treated with nitric acid, carbonic acid gas and nitrous gas are evolved. The cork is decomposed, and converted, partly into a yellow, soft, unctuous matter, which swims on the surface, and partly into suberic acid; the nature and properties of which have been already described. See CORK, where will be found an account of the SUBERIC *acid*, SUBERATES, &c.

SUBLIMATION, in chemistry, a process by which certain volatile substances are raised by heat, and again condensed by cold into a solid form. Thus, sulphur exposed to heat in close vessels, is volatilized or sublimed in the form of very white powder, known by the name of "flowers of sulphur." The formation of soot in our chimneys is another instance of sublimation. Benzoin, sublimated, gives flowers of benzoin, a very beautiful substance, which is now more properly called benzoic acid. Sublimation may be performed, in many cases, with common flasks: thus, if a small quantity of sal ammoniac is put into a flask, and heat applied to is, the entire salt arises in the form of white smoke, and condenses in the upper part of the flask, in the form of minute crystalline particles, which is a sublimate.

SUBLIME, in discourse, is defined by Boileau, to be something extraordinary and surprising, which strikes the soul, and makes a sentiment or composition ravish and transport.

Longinus makes five sources of the sublime: the first, a certain elevation of the mind, which makes us think happily: the second is the pathetic, or that natural vehemence and enthusiasm which strikes and moves us; these two are wholy owing to nature, and must be born with us; whereas the rest depend partly on art: the third is the turning of figures in a certain manner, both those of thoughts and of speech: the fourth, nobleness of expression; which consists of two parts, the choice of words, and the elegant figurative diction; the fifth, which includes all the rest, is the composition and arrangement of the words in all their magnificence and dignity.

SUBMULTIPLE, in geometry, &c. A submultiple number, or quantity, is that which is contained a certain number of times in another, and which, therefore, repeated a certain number of times, becomes exactly equal thereto: thus 3 is a submultiple of 21; in which sense submultiple coincides with an aliquot part.

SUBMULTIPLE *ratio*, is that between the quantity contained and the quantity containing: thus the ratio of 3 to 21 is submultiple. In both cases, submultiple is the reverse of multiple, 21, *e. g.* being a multiple of 3, and the ratio of 21 to 3 a multiple ratio.

SUBNORMAL, in geometry, a line which determines the point in the axis of a curve, where a normal, or perpendicular raised from the point of contact of a tangent to the curve, cuts the axis. Or the subnormal is a line which determines the point, wherein the axis is cut by a line falling perpendicularly on the tangent in the point of the contact.

SUBPŒNA, is a writ, whereby all persons under the degree of peers are called into Chancery, in such case only where the common law fails, and has made no provision; so as the party, who in equity hath wrong, can have no other remedy by the rules and course of common law. It is, therefore, the commencement of a suit in equity. But the peers of the realm in such cases are called by the Lord Chancellor's or Lord Keeper's letters, giving notice of the suit intended against them, and requiring them to appear. There is also a *subpœna ad testificandum*, or a subpœna to give evidence for the summoning the witnesses, as well in Chancery as other courts. There is also a subpœna in the Exchequer, as well in the court of

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equity there, as in the office of pleas; which latter is a writ that does not require personal service, and is the commencement of a suit at common law there.

SUBSTANTIVE, in grammar, a noun, or name, considered simply and in itself, without any regard to its qualities, or other accidents, in contradistinction to the noun termed adjective, or that which expresses a certain quality or accident of the noun substantive. See GRAMMAR.

SUBTRACTION. See ARITHMETIC and ALGEBRA.

SUBTANGENT *of a curve*, in the higher geometry, is the line which determines the intersection of the tangent with the axis; or that determines the point wherein the tangent cuts the axis prolonged. In any equation, if the value of the subtangent comes out positive, it is a sign that the points of intersection of the tangent and axis fall on that side of the ordinate where the vertex of the curve lies, as in the parabola and paraboloids: but if it comes out negative, the point of intersection will fall on the contrary side of the ordinate, in respect of the vertex, or beginning of the abscissa, as in the hyperbola and hyperboliform figures. And universally, in all paraboliform and hyperboliform figures the subtangent is equal to the exponent of the power of the ordinate, multiplied into the abscissa. See TANGENT.

SUBTENSE, in geometry, the same with the chord of an arch. Hence the subtense of an angle is a right line, supposed to be drawn between the two extremities of the arch that measures that angle.

SUBTRIPLE *ratio*, is when one number, or quantity, is contained in another three times: thus, 2 is said to be subtriple of 6, as 6 is triple of 2.

SUBULARIA, in botany, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ or Cruciformes Cruciferæ, Jussieu. Essential character: silicle entire, ovate; valves ovate, concave contrary to the partition; style shorter than the silicle. There is only one species, *viz.* S. aquatica, awl-wort, a native of the northern parts of Europe.

SUCCESSOR, in law, is he who follows or comes in another's place. An aggregate corporation, or body composed of many persons, may have a fee simple estate in succession without the word successors; and take goods and chattels in action or possession, and they shall go to the successors.

SUCCINATES. See SUCCINIC acid

SUCCINIC *acid*, in chemistry, obtained from the decomposition of amber, was formerly called volatile salt of amber, and regarded as an alkaline salt. It was not till towards the end of the seventeenth century, that its acid properties were discovered. See AMBER.

The name of the acid is derived from succinum, the Latin name for amber. It may be obtained by the following process: Introduce a quantity of amber, in powder, into a retort, and let it be covered with dry sand. Adapt a receiver, and distil with a moderate heat in a sand bath. There passes over first a liquid, which is of a reddish colour, and afterwards a volatile acid salt, which crystallizes in small white or yellowish needles in the neck of the retort; and if the distillation be continued, a white, light oil succeeds, which becomes brown, thick, and viscid. The acid which is obtained in this way is contaminated with the oil; and therefore, to separate this oil, it may be dissolved in hot water, and passed through a filter, on which has been placed a little cotton moistened with oil of amber, which retains the oil, and prevents it from passing through along with the acid. The acid may then be evaporated and crystallized. The crystals are four-sided, rhomboidal plates, which, if pure, are white. Their taste is sour, and they redden an infusion of litmus. They are soluble in twenty-four parts of cold water, but in much less of hot. They are soluble also in alcohol. This acid is volatile and inflammable: its base is a compound of carbon and hydrogen. It combines with the alkalies, earths, and metallic oxides, forming therewith salts called succinates. Most of these crystallize, as the succinate of potash, soda, lime &c. but the succinate of magnesia will not crystallize, but by evaporation forms a viscid mass. The metallic succinates are likewise soluble and crystallizable.

SUCCULENTÆ, in botany, the name of the thirteenth order in Linnæus's Fragments of a Natural Method, consisting of flat, fleshy, succulent plants, of which the greater part is evergreen: among these are the cactus, Indian fig; sedum, lesser house leak; and the saxifrage.

SUCTION, the act of sucking or drawing up a fluid, as air, water, milk, or the like, by means of the mouth and lungs. There are many effects vulgarly attributed to suction, which, in reality, have very different causes. As when any one sucks water, or any other liquor, up

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through a pipe, it is commonly thought, that by that action the person draws the air up into his mouth, and that the water, which is contiguous to it, follows it by a kind of attraction, as if the air and water hung together; and others fancy, that the air moves into the mouth of the sucker, and the water moves up after the air to prevent a vacuum, which, they say, nature abhors: whereas the true cause of this phenomenon is only that the air or atmosphere presses, with its whole weight, uniformly on the surface of the liquor in the vessel: and, consequently, prevents any one part of the water to rise higher than the other there: and if a pipe be put in, of any tolerable large bore, and be open at both ends, the water will rise within the pipe to the same height as without, and, indeed, a little higher, because the pressure of the air within the pipe is a little taken off by bearing against the side of the pipe. Now when any one applies his mouth to the upper end of the pipe, and sucks, his lips so strongly inclose the pipe, that no air can get between them and it; and, by the voluntary motion of the muscles, the cavity of his thorax, or breast, is opened and enlarged: by which means the air, included there, hath now a much larger space to dilate itself in, and, consequently, cannot press so strongly against the upper end of the pipe, as it did before the cavity of the thorax was so enlarged, and when the weight of the whole atmosphere kept its spring bent. And that weight or pressure being now taken off by the lips of the man that sucks, the equilibrium is destroyed, the air gravitates on the surface of the water, but cannot do so on the upper orifice of the pipe, because the juncture of the lips takes it off; and the spring of the air included in the thorax being weakened by the dilation of its cavity, it cannot press so hard against the upper orifice of the pipe, as the water will do against the lower, and, consequently, the water must be forced up into the pipe. It is much the same thing in the suction of a common pump; the sucker, being tight, takes off entirely the pressure of the atmosphere on the surface of the water within the barrel of the pump; and, consequently, the atmosphere, by its weight, must force the water up, to make the equilibrium.

SUFFERANCE, in law. Tenant at sufferance is he who holdeth over his term, at first lawfully granted. A person is tenant at sufferance, who continues after his estate is ended, and wrongfully holds against another. Tenants holding over, after determination of their term, and after demand made in writing to deliver possession, are rendered liable to pay double the yearly value. And tenants giving notice of their intention to quit, and not accordingly delivering up the possession at the time in such notice contained, are rendered liable to pay double rent. And it has been held, that under this latter act the notice need not be in writing, and that the landlord may levy his double rent by distress.

SUFFRAGAN, a titular bishop, appointed to aid and assist the bishop of the diocess.

SUGAR exists in every part of plants. It is found in the roots, as those of the carrot and beet root; in the stems, as in the birch, the maple, some palms, and especially the sugar cane; in the leaves, as those of the ash; in the flowers, the fruits, and seeds. But the sugar which now forms a very extensive article of commerce, and may be considered as a necessary of life, is entirely obtained from the juice of the sugar cane, which is chiefly cultivated in the East and West Indies, by planting cuttings of it in the ground in furrows, dug parallel for that purpose; the cuttings are laid level and even, and are covered up with earth; they soon shoot out new plants from their knots or joints; the ground is to be kept clear, at times, from weeds, and the canes grow quick. When the plants have arrived at their full growth, which, in the West Indies, is in the course of twelve or fourteen months, they are cut down and bruised by means of machinery.

The sugar mill is composed of three rollers of an equal size, and all armed with iron plates, where the canes are to pass between them; only the middle roller is much higher than the rest, to give the larger sweep to the two poles to which the horses are yoked. This great roller in the middle is furnished with a cog full of teeth, which catch the notches in the two side rollers, and force them about, to bruise the canes, which pass quite round the great roller, and come out dry and squeezed from all their juice, which runs into a vessel or back under the mill, and is thence conveyed through a narrow spout into the first boiler.

Sugar mills are, however, differently constructed, but in Plate Sugar Mill are the plan and elevation of one made by Mr. Thomas Rowntree, Blackfriar's

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Road, Southwark, and sent by him to the West Indies.

A B and D E (fig. 1 and 2.) are four ground sills, crossing and halved into each other; on the points of intersection four uprights are framed F F F F; these are connected at top by cross pieces *a a b b*; *e* (in fig. 2.) is another similar framing between the uprights.

Three blocks of wood are fixed crosswise between the beams *e e*, and similar ones cross between the upper ones *a a*, to support the bearings for the three rollers, *f g h*; these rollers are made of cast iron, and turned in the lathe; they have cog wheels at their upper ends, that they may all turn together; the axis of the middle roller, *g*, is much longer than the two others, and at the upper end is square; a strong wooden cross plate, with iron, *i k*, is fitted on it; some distance above this, it has a square piece of iron, *n*, fixed on its spindle; the long levers, *m m*, by which it is turned, are bolted at their ends to the piece of iron *n*, and to the ends of the wooden cross *i k*; the harness of two mules is made fast to the end of each lever, by hooking their traces into the rings at the end of the levers. In this manner the middle roller is turned round, and, by the cogs, the other two by the side of it. The pivots of the rollers are cylindrical, and each turns between six friction rollers, which traverse in a frame made fast to the cross beams, between *a a* and *e e*; the outside of two of these beams slide in rebates cut in the beams *a a* and *e e*, and can be moved up towards the middle rollers by wedges *t t t t*; the weight of each roller is supported on three friction wheels below its lower pivot. The construction of a set of these friction wheels is shown in figs. 3 and 4. Fig. 4 is an elevation, and fig. 3 a plan; *a* (fig. 4) is the end of the pivot; below this it is turned smaller, nearly to the size of the small circle in fig. 3. so as to leave a square shoulder; *b* is a circular brass plate, fitted upon the small part of the pivot, and resting against the shoulder; *d* is another similar plate supported by a block of wood, seen in fig. 2, laying on the ground sills D E (fig. 2;) the small part of the pivot comes down beyond the plate, *b*, and enters a hole through a thick iron ring, *e*, (fig. 3;) this ring has the three arms projecting from it, which serve as pivots to the three friction rollers *l m n*; it is upon these rollers the upper plate, *b*, and the weight of the great roller rests: as the pivot, *a*, and the upper plate, *b*, turn round, the three rollers roll round upon the under plate *d*; the iron ring, *e*, has no share in holding the weight, its use is only to keep the three rollers in their places, and in the same manner the small part of the pivot keeps the ring in its place.

A wooden trough is laid upon the beams, *e e*, at *w*, to receive the juice expressed from the canes by the rollers; the holes in the bottom of this trough, through which the pivots of the rollers pass, have their orifices above the surface of the liquor in the trough, so that it cannot get down to the friction rollers. A small trough leads from the trough at *w*, and conveys away the liquor, (going under the mule walk,) to the boiling house.

The operation of the machine is exceedingly simple; a person presents the ends of the canes to the rollers, *f g*; by their motion the canes are drawn in between them; another person behind bends the ends of the canes as they come through, that they may pass between the other two, *g h*, and thus come out again in the front of the machine, squeezed dry from the juice they before contained. The juice which is collected is conveyed to iron boilers, where it is boiled, with the the addition of a small quantity of quicklime, and the impurities which rise to the surface are scummed off. The boiling is continued till it acquires the consistence of syrup, after which it is put into shallow vessels, where it is allowed to cool and granulate. In general, it is afterwards put into hogsheads, in which it is imported to Europe, the bottoms of which are perforated, that the molasses, with which the sugar is mixed, may be allowed to drain off. Sometimes it is put into conical earthen vessels, open at both ends, the base of which is covered with moist clay, so that the water filters through the sugar, and carries with it a greater quantity of the molasses, and other impurities. The sugar thus treated is called clayed sugar. It is not different from the former, but being somewhat purer. The addition of quicklime in the boiling is supposed to take up some vegetable acids which prevent the granulation of the sugar. In this state the sugar is known in commerce by the name of raw or Muscovado sugar. It is still further purified by dissolving it in water, and boiling, when the impurities, which rise to the surface, are again removed: a quantity of lime is also added, and it is clarified with blood. When boiled down to a proper consistency, it is put into unglazed earthen vessels, of a conical shape, and

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inverted, to allow the water from the moist clay, with which the base of the cone is covered, to pass through the sugar, and carry off its impurities.

According to the number of processes to which it has been subjected, it is called single or double refined sugar. Sugar in this state is of a white colour: it is well known for its sweet taste; it has little or no smell. It has some degree of transparency when it is crystallized. It is considerably hard, but it is brittle, and may be easily reduced to powder. It is phosphorescent in the dark. When the solution of sugar in water is concentrated, it crystallizes in the form of six-sided prisms, terminated by two-sided summits. The specific gravity of sugar is 1.4. When sugar is exposed to heat, it melts, swells up, becomes of a dark brown or black colour, emits air-bubbles with a peculiar smell, which has been called caromel. If a red heat be applied, it suddenly bursts into flames, with a kind of explosion. It is very soluble in water; at so low a temperature as 48° water dissolves its own weight of sugar. This power increases with the temperature of the water. When water is saturated with sugar, it is called syrup, which by concentration and rest affords crystals. Sugar is soluble in many of the acids. It is decomposed by sulphuric acid; when heat is applied, the acid itself is decomposed, and converted into sulphurous acid; and a great quantity of charcoal is deposited. Nitric acid acts on sugar with considerable violence; an effervescence is produced, nitrous gas is emitted, and the sugar is converted into oxalic and malic acids. Muriatic acid gas is slowly absorbed by sugar, which becomes of a brown colour, and acquires a very strong smell. Sugar is instantly dissolved, when it is thrown in the state of powder into liquid oxymuriatic acid; it is converted into malic acid, while the oxymuriatic acid is deprived of its oxygen, and reduced to the state of muriatic acid. Alcohol readily dissolves sugar. One part of sugar is soluble in four of boiling alcohol. Sugar also combines with the oils, and by this means they may be mixed with water. The fixed alkalies combine with sugar, and deprive it of its sweet taste; but by adding sulphuric acid, and precipitating the sulphate, which is formed by means of alcohol, the taste is restored. Some of the earths, as lime, combine with sugar, and form similar compounds. The sulphurets and phosphurets of the alkalies, and some of the earths decompose sugar, and reduce it to a state somewhat similar to gum. By distilling sugar in a retort, the first part of the product is water, nearly in a state of purity. Acetic acid with a little oil next comes over, and afterwards empyreumatic oil. A bulky carbonaceous matter, which sometimes contains a little lime, remains behind. Mr. Cruikshank obtained, by the distillation of 480 grains of pure sugar, by means of a red heat,

	gns.
Acetic acid and oil - -	270
Charcoal - - - - - - -	120
Carbonated hydrogen and carbonic acid gases	90
	480

Sugar, therefore, is composed of oxygen, carbon, and hydrogen.

The proportions of its constituent parts, according to Lavosier, are the following:

Oxygen - - - - - - - -	64
Carbon - - - - - - - -	28
Hydrogen - - - - - - -	8
	100

Sugar is also obtained from the juice of the maple tree in North America. See MAPLE.

It has lately been proposed to extract sugar from the root of the beet; and the attempt has been made, even in the large way, by Achard of Berlin. The process which he followed is to boil the roots, cut them into slices, and extract the juice by pressure.

Many other plants also contain sugar, either in the roots, the sap, or the seeds. It exists in wheat, barley, beans, peas, and other leguminous seeds, especially when they are young, in considerable quantity. The uses of sugar are so familiar, that it is scarcely necessary to enumerate them. In most countries, where it can be obtained, it may be considered in some measure as a necessary of life. It contains a great proportion of nutritious matter; animals, when partially supplied with it, become fat and vigorous. It is not changed by the action of the air, so that it may be preserved for any length of time. It is employed to preserve other vegetable matters from putrefaction, and sometimes it is also advantageously applied to a similar purpose, in the preservation of animal substances. It is used likewise in the composition of some varnishes of ink, and

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of some pigments, to communicate to them a degree of gloss or lustre.

SUIT, in law, is used in different senses: first, in a suit of law; and is divided into real and personal, and is the same with action real and personal; secondly, suit of court, or suit service, is an attendance that tenants owe to the court of their lord. Thirdly, suit covenant, is where the ancestor hath covenanted with another to sue to his court. Fourthly, suit custom, when a man and his ancestors have been seised, time out of mind, of his suit. Fifthly, suit real, or regal, when men come to the sheriff's town, or leet. Sixthly, suit signifies the following one in chase, as fresh suit. Lastly, it signifies a petition made to the king, or any great person.

SUKOTYRO, in natural history, a genus of Mammalia, of the order Bruta. Generic character: horn on each side near the eyes. The only species of this genus is the S. indicus, first noticed by a Dutch traveller in the seventeenth century, and which has indeed never been described by any other. It is represented as equal in size to a large ox, and possessing the snout of a hog, with ears rough and long, different from the position of those of all other quadrupeds, tail bushy, eyes upright in the head, and next to these having on each side a horn or tusk, approaching in size to that of an elephant. It is said to be a native of Java, and to feed on herbage. As this account, however, does not appear to have been confirmed by any traveller since Niewhoffe's time, and some of his representations in natural history are extremely slovenly and incorrect, it does not appear a very blameable scepticism to doubt the existence of such an animal. See Mammalia, Plate XX. fig. 4.

SULPHATES, in chemistry, salts formed by the combination of any base with the sulphuric acid; of these we shall notice only the sulphate of soda, known in the shops by the name of Glauber's salts. This salt was discovered by the alchymist Glauber; but since his time it has been largely used in medicine. Chemists have described various modes of obtaining this salt. It exists likewise native in mineral springs, and sometimes it effloresces on the walls of old buildings. Sulphate of soda crystallizes in six-sided prisms, bevelled at the extremities, and longitudinally grooved: its taste is strongly saline and bitter. It is efflorescent, and when exposed to a very dry atmosphere, the surface of the crystals soon becomes white and opaque, and at length they fall into powder; it is soluble in rather less than three times its weight of water at 60°, and in less than its own weight of boiling water. The sulphate of soda, when crystallized, is composed of

Soda - - - - - - - -	18.48
Sulphuric acid - - -	23.52
Water - - - - - - -	58.00
	100.00

SULPHITES, salts formed by the combination of any base with the sulphurous acid. These have always a disagreeable sulphurous taste; they are decomposed by the nitric, muriatic, and some other acids; they are converted into sulphates by exposure to the atmosphere, drawing from it the oxygen. These salts were first noticed and described by Stahl: they are mostly formed artificially by saturating the alkaline and earthy bases with sulphurous acid.

SULPHUR, an inflammable fossil, of which there are two species, *viz.* common natural sulphur, and volcanic natural sulphur. The colour of the natural sulphur is yellow, of different degrees of intensity; it occurs massive, disseminated, and crystallized. The crystals are middle sized and small, of which the surface is smooth and splendent. Internally it is intermediate between shining and glistening. It is soft and frangible. When placed on inflamed coals, it burns with a bluish flame, and emits a pungent suffocating vapour, and is totally volatilized. It is found in many parts of the world. It occurs commonly in masses, in gypsum, lime-stone, and marl: and in some places, with honey-stone, and bituminous wood. It is often found in veins that traverse primitive rocks; in veins of copper pyrites that traverse granite; in Siberia it is found in the gold mines of Catherineburg, and in the lead glance veins in the Altain mountains. Humboldt mentions a province of Quito, in which he discovered a bed composed of sulphur and quartz, in a mountain of mica slate; he likewise found great quantities of sulphur in primitive porphyry.

The volcanic natural sulphur is yellow, inclining to green: it occurs sometimes corroded; sometimes as a sublimate in flowers. It is glistening, and its lustre is resinous, inclining to adamantine. It occurs only in volcanic countries, where it is found in greater or smaller quantity among the lava. Solfatara, in the vicinity of Vesuvius, is one of the most famous

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repositories of natural volcanic sulphur, and is there collected in considerable quantities for the purposes of commerce. It is found also in Iceland, in Etna, and in the Lapari islands. It occurs likewise in the island of Teneriffe, and in the West India islands; in Java, and the East Indies. Having thus described this substance mineralogically, we turn to it in a chemical view.

Sulphur is a simple undecompounded combustible substance, which is universally diffused in nature; but most commonly in a state of combination with mineral, vegetable, or animal matters. It is found in some mineral waters, but in greatest abundance in volcanic countries, where it is a valuable article of commerce. Sulphur, as it is extracted from minerals and purified by art, is a hard, brittle substance, of a yellow colour, which can be easily reduced to powder. It is always opaque, has a lamellated fracture, and becomes electric by friction. The specific gravity, after it is melted, does not exceed 1.99. It has no smell, and very little perceptible taste. When it is rubbed some time it is volatilized, and diffuses a peculiar and slightly fœtid odour, by which it is easily distinguished. It leaves on the skin which has been in contact with it a very strong smell, which remains for some hours. It is insoluble in water. Light has no sensible effect on sulphur. But if a roll of sulphur be held in the hand for a little, it begins to crackle, and at last it breaks to pieces. When a temperature equal to that of boiling water is applied to sulphur, it melts, becomes liquid and transparent, and changes to a brown red colour: but on cooling, if the fusion is not too long continued, it resumes the yellow colour. If it be permitted to cool slowly, it crystallizes into prismatic needles. The crystals are better formed by pouring out part of the liquid sulphur as soon as the surface has become solid. If the heat be continued, it becomes thick and viscid; and if it be then poured into cold water, it retains its softness, so that it is employed for taking impressions of seals and medals. In this state they are called sulphurs. When sulphur is exposed to heat in close vessels, it is volatilized or sublimed in the form of very fine powder, known under the name of flowers of sulphur. Sulphur enters into combination with oxygen, azote, hydrogen, carbon, and phosphorus. When sulphur is kept some time in fusion in an open vessel, it assumes a red colour, and becomes viscid. After it is cooled, it retains its red colour, which is owing to the combination of oxygen in small proportion with the sulphur. In this state it has been denominated the oxide of sulphur.

According to the experiments of Dr. Thomson, the oxide of sulphur, formed by melting the substance in a deep vessel, is of a dark violet colour, fibrous fracture, and tough consistence; the specific gravity is 2.3. Another oxide was formed by passing a current of oxymuriatic acid gas through flowers of sulphur. When sulphur is burnt in the open air, it emits a pale blue flame, with a great quantity of white smoke. When these fumes are mixed with water, it is found to possess acid properties. This is a combination of sulphur with a greater proportion of oxygen than exists in the oxide, and is called sulphurous acid. But when sulphur is burnt in oxygen gas, a very rapid combustion takes place, with a reddish white flame, and it combines with a greater proportion of oxygen. When the fumes, which are copiously emitted during this combustion, are collected, and mixed with water, it exhibits the properties of an acid, which is the sulphuric acid. Thus it appears, that sulphur combines with oxygen in four different proportions. In two of these, in which the proportions are the smallest, the compounds are denominated oxydes; but in the two others, in which the proportion of oxygen is increased, the compounds are acids, the properties of which will be afterwards noticed.

SULPHURETS, in chemistry. Sulphur combines with the fixed alkalies, forming compounds called sulphurets. These exist only in a concrete state, as when dissolved in water, a decomposition takes place. We may notice, as an example, the sulphuret of potash, which is formed by exposing to heat, in a covered crucible, equal weights of sulphur and the dry concrete alkali. When it has become concrete, it is firm and brittle, and of a reddish brown colour, which, from its resemblance to the liver of an animal, obtained the name of hepar sulphuris, liver of sulphur. This substance, while dry, is inodorous, but when moistened it acquires a fetid smell, from the production of sulphuretted hydrogen. It fuses when exposed to a strong heat. A singular property belonging to this substance is, that when fused with some metals, as gold, a combination is formed, which is soluble in water.

SULPHURETTED *hydrogen*, is a compound of sulphur and hydrogen, and it owes its origin to the decomposition of

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water in the processes by which it is formed. This substance is obtained by various methods, which are detailed by writers on chemistry. It may be had by exposing to a strong heat mixtures of sulphur with vegetable matters, as sugar, oil, &c. The specific gravity is as 1.142 to 1. Its smell is extremely fœtid, approaching to that denominated putrid, the effluvia disengaged in the processes of putrefaction consisting partly of this gas. It extinguishes combustion, and is incapable of supporting animal life. If sulphuretted hydrogen gas be kindled in contact with the atmospheric air, it burns with a blue lambent flame. When mixed with atmospheric air, it does not detonate, and the combustion of its elements is not complete, part of the sulphur being deposited on the sides of the vessel. With oxygen gas it detonates. Sulphuretted hydrogen has a peculiar action on metals, by tarnishing them, and communicating to them shades of yellow, purple, &c. It is possessed of the properties of an acid, and enters into combination with the alkalies, and forms compounds, some of which are crystallizable. It changes vegetable blues to red. It decomposes soap; combines with the metallic oxides; and precipitates sulphur from its combinations with potash or lime.

SULPHURIC *acid*, in chemistry. The name of sulphuric acid is given to the combination of sulphur and of oxygen, with the greatest proportion of the latter. It was formerly called vitriolic acid, because it was obtained from vitriol by distillation, which is a compound of sulphuric acid and an oxide of iron. When it is strongly concentrated, it is called oil of vitriol. If a quantity of flowers of sulphur be exposed to a degree of heat sufficient to inflame it, and if, when it is in a state of ignition, it be introduced into a jar filled with oxygen gas, it burns with great splendour, and emits a great quantity of white fumes. These fumes may be condensed, by pouring a small quantity of water into the jar, and when this is examined, it is found to possess acid properties. This is the sulphuric acid. It is procured, as appears by this experiment, by burning sulphur in oxygen gas.

The process for obtaining sulphuric acid, in the large way, is the following. A mixture of sulphur and nitre is burnt in leaden chambers. The use of the nitre is, to supply a quantity of oxygen for the combustion of the sulphur. There is a little water in the bottom of the vessel, which serves to condense the vapours given out during combustion.

The acid which is obtained in this way is very weak, for it is diluted with the water in which it was condensed, which water may be separated by distillation. Even after this it is usually contaminated with a little lead from the vessels, some potash, and sometimes nitric and sulphurous acids. To obtain it perfectly pure, the sulphuric acid of commerce must be distilled. This process is conducted by putting a quantity of the acid into a retort, and exposing it to a degree of heat sufficient to make it boil. The beak of the retort is put into a receiver, in which the acid, as it come over, is condensed. The acid thus purified, is a transparent colourless liquid, of an oily consistence. It has no smell, but a strong acid taste. It destroys all animal and vegetable substances. It reddens all vegetable blues. It always contains water. When this is driven off by a moderate heat, the acid is said to be concentrated. When as much concentrated as possible, the specific gravity is 2, or double that of water; but it can rarely be obtained of greater density than 1.8. The sulphuric acid suffers no change from being exposed to the light. It boils at the temperature of 546°, or, according to Bergman, 540°. When this acid is deprived of its caloric, it is susceptible of congelation, and even of crystallization, in flat, six-sided prisms, terminating in a six-sided pyramid. It crystallizes most readily, when it is neither too much concentrated, nor diluted with water. Of the specific gravity of 1.6, it crystallizes at the temperature of a few degrees below the freezing point of water. Of the specific gravity of 1.8, it resists the greatest degree of cold. Chaptel observed it crystallize at the temperature of 48°, and Mr. Keir found that it froze at 45° of the specific gravity of 1.78. Sulphuric acid has a strong attraction for water.

In some experiments that have been made, sulphuric acid, when exposed to the atmosphere, attracted above six times its weight of water. When four parts of concentrated sulphuric acid, and one part of ice at the temperature of 32°, are mixed together, the moment they come in contact the ice melts, and the temperature rises to 212°. A greater quantity of caloric is given out, when the two bodies are mixed together in the liquid state. If four parts of the acid and one of water are suddenly mixed together, the temperature of the mixture rises to about 300°. This extrication of caloric, it is

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obvious, arises from the sudden condensation of the two liquids, the medium bulk of which is considerably less than the two taken together. So great is the attraction of this acid for water, that the strongest that can be prepared can scarcely be supposed to be entirely free from it. Attempts have been made to determine the proportion of oxygen and sulphur, which enter into the composition of sulphuric acid. According to the experiments of Lavoisier, in which he measured the quantity of oxygen absorbed by a given weight of sulphur during combustion, the proportions are,

Sulphur	71
Oxygen	29
	100

But other methods have been adopted. These are, by decomposing other substances which contain oxygen, by means of sulphur. According to the experiments of M. Chevenix, conducted in this way, the sulphuric acid consists of,

Sulphur	61.5
Oxygen	38.5
	100.0

Sulphuric acid does not combine with oxygen, nor has it any action with azotic gas. It appears that hydrogen has a greater affinity for oxygen than the sulphur has, and therefore the sulphuric acid is decomposed by means of hydrogen gas. In the cold there is no action between hydrogen gas and sulphuric acid; but if they are made to pass through a red hot porcelain tube, the acid is decomposed, water is formed, and sulphur is precipitated. When hydrogen gas is employed in a greater proportion than the half of the acid, the superabundant gas dissolves the sulphur, and is disengaged in the form of sulphurated hydrogen gas. Charcoal has no action on sulphuric acid in the cold; but at the boiling temperature it decomposes it, and converts it into sulphurous acid. If a piece of red hot charcoal be immersed in a quantity of concentrated sulphuric acid, part of the acid is suddenly disengaged under the form of thick white fumes, accompanied with sulphurous acid gas. The sulphuric acid is decomposed; part of its oxygen is attracted by the charcoal, forming carbonic acid, and thus it is reduced to the lowest proportion of oxygen, in the state of sulphurous acid. A similar effect is produced by phosphorus. Phosphorus, with the assistance of heat, partially decomposes the sulphuric acid, by abstracting part of its oxygen. Phosphoric acid is formed, and sulphurous acid driven off. In the cold, sulphur has no action on sulphuric acid; but when they are boiled together, the sulphur is partly dissolved in the acid, and converts it into sulphurous acid. The sulphur which has been added combines with the oxygen, which is necessary for the constitution of sulphuric acid, and thus the whole is converted into sulphurous acid. Sulphuric acid combines with alkalies, the earths, and the metals forming salts; which in the present language of chemistry are denominated sulphates. This acid is employed in great quantity in many arts and manufactures. It is employed also in medicine and pharmacy; the preparation of it, therefore, has long been an object of considerable importance.

SULPHUROUS *acid*, was formerly called spirit of sulphur, and volatile sulphurous acid. It was not till the year 1774 that its nature and composition were discovered by the labours of Priestley and Lavoisier. Berthollet afterwards investigated the formation, decomposition, combinations, and uses, of this acid. Fourcroy and Vauquelin also have examined many of its properties, especially the saline compounds which it forms, so that now its properties are well known. The sulphurous acid exists in nature in great abundance, and particularly in the neighbourhood of volcanoes. It is disengaged from some lavas in a state of fusion, and from the soil which is impregnated with sulphur, when a sufficient degree of heat is applied. It was by the vapours of sulphurous acid that Pliny the naturalist was suffocated in the eruption of Mount Vesuvius, which destroyed Herculaneum, in the 79th year before the Christian æra. When sulphur is burnt in the open air, the fumes that are generated by this slow combustion are sulphurous acid. It was in this way that this acid was formerly obtained. The method of procuring it, which is now followed, is, to decompose the sulphuric acid by means of any substance which deprives it of part of its oxygen. If one part of mercury and two parts of concentrated sulphuric acid be exposed to heat in a glass retort, the mixture effervesces, and a gas is disengaged, which may be collected in jars over mercury In this process the mercury attracts part of the oxygen of the sulphuric acid, and leaves behind that portion which constitutes the sulphurous acid. Sulphurous acid thus obtained is in the state of gas, and it is an

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elastic, invisible, and colourless fluid, like common air. It is rather more than double the weight of atmospheric air. It reddens vegetable blues, and then destroys the greater number of them. It is on account of this property that the fumes of sulphur are employed to remove the stains of fruit from linen, and that the sulphurous acid is often used in bleaching. When the sulphurous acid is in the form of gas, it does not readily combine with oxygen. In its fluid form it unites more readily, and is converted into sulphuric acid. In making a mixture of sulphurous acid gas and oxygen gas pass through a red hot tube, they combine together, and are converted into sulphuric acid. There seems to be no action between sulphurous acid and azotic gas. Water has a strong attraction for sulphurous acid gas. A piece of ice brought in contact with it is immediately melted, without any perceptible change of temperature. When water is saturated with this gas, it is known by the name of sulphurous acid, or liquid sulphurous acid. The specific gravity is 1.04. At the temperature of 43° water combines with one-third of its weight of sulphurous acid gas; but as the temperature increases, it absorbs it in smaller proportion. It freezes at a temperature a few degrees below 32°, and it passes into the solid state without parting with any of its acid. The liquid sulphurous acid has the smell, taste, and other properties of the gas, and particularly that of destroying vegetable colours. When exposed to the atmosphere, it gradually absorbs oxygen, and passes into the state of sulphuric acid. This change goes on more rapidly when it is diluted with water, and agitated in contact with the air. The sulphuric acid separates the sulphurous acid in the gaseous form from its combinations, and even from water. Concentrated sulphuric acid absorbs this gas, which imparts to it a yellowish brown colour, and renders it pungent and fuming. The two acids strongly attract each other, so that when they are exposed to the action of heat, the first vapour which rises crystallizes in long, white, needle-shaped prisms. This is a compound of the two acids. It smokes in the air, dissolves with effervescence in it, and when thrown into water produces a hissing noise, like a red-hot iron. Sulphurous acid is very much employed in the arts, and sometimes in medicine. In the state of gas it is used for the bleaching of silk and wool, by extracting the colouring matter. It removes also the stains arising from vegetable juices, and spots of iron from linen. According to Fourcroy, 100 parts of this acid are composed of

Sulphur	85
Oxygen	15
	100

But according to the analysis of Dr. Thomson,

Sulphur	68
Oxygen	32
	100

The compound salts formed by this acid are denominated sulphites.

SUM, in mathematics, signifies the quantity that arises from the addition of two or more magnitudes, numbers, or quantities together. The sum of an equation is, when the absolute number being brought over to the other side of the equation, with a contrary sign, the whole becomes equal to 0: thus, the sum of the equation $x^3 - 12x^2 + 41x = 42$, is $x^3 - 12x^2 + 41x - 42 = 0$.

SUMMER, in architecture, is a large stone, the first that is laid over columns and pilasters, in beginning to make a cross vault.

Summer, in carpentry, is a large piece of timber, which, being supported on two stone piers, or posts, serves as a lintel to a door, window, &c.

SUN, in astronomy, the most conspicuous of the heavenly bodies, which occupies the centre of the system which comprehends the earth, the primary and secondary planets, and comets. The sun is the magnificent luminary which enlightens these worlds, and by its presence constitutes day. We have referred to this article from the fixed Stars, because the sun agrees with them in several particulars, as in the property of emitting light continually, and in retaining constantly its relative situation, with but little variation: they may have probably many other properties in common. The sun is, therefore, justly considered as a fixed star comparatively near us; and the stars as suns at immense distances from our earth; and we reasonably infer, from the same analogy, that the stars are possessed of gravitation, and of the other general properties of matter; they are

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supposed to emit heat as well as light; and it has been conjectured that they serve to cherish the inhabitants of a multitude of planetary bodies revolving round them.

In a paper on the "Constructions of the Heavens," Dr. Herschel says it is very probable, that the great stratum called the milky way, is that in which the sun is placed, though perhaps not in the centre of its thickness, but not far from the place where some smaller stratum branches from it. Such a supposition will satisfactorily, and with great simplicity, account for all the phenomena of the milky way, which, according to this hypothesis, is no other than the appearance of the projection of the stars contained in this stratum, and its secondary branch. See GALAXY.

In another paper on the same subject, he says that the milky way is a most extensive stratum of stars of various sizes admits no longer of the least doubt; and that our sun is actually one of the heavenly bodies belonging to it is as evident.

We will now, says the Doctor, retreat to our own retired station in one of the planets attending a star in the great combination, with numberless others; and in order to investigate what will be the appearances from this contracted situation, let us begin with the naked eye. The stars of the first magnitude, being in all probability the nearest, will furnish us with a step to begin our scale; setting off, therefore, with the distance of Sirius or Arcturus, for instance, as unity, we will at present suppose that those of the second magnitude are at double, and those of the third are treble the distance, and so forth. Taking it then for granted, that a star of the seventh magnitude is about seven times as far from us as one of the first, it follows, that an observer, who is enclosed in a globular cluster of stars, and not far from the centre, will never be able, with the naked eye, to see to the end of it; for since, according to the above estimations, he can only extend his view about seven times the distance of Sirius, it cannot be expected that his eyes should reach the borders of a cluster, which has, perhaps, not less than fifty stars in depth every where around him. The whole universe, therefore, to him, will be comprised in a set of constellations, richly ornamented with scattered stars of all sizes. Or if the united brightness of a neighbouring cluster of stars should, in a remarkably clear night, reach his sight, it will put on the appearance of a small, faint, nebulous cloud, not to be perceived without the greatest attention. Allowing him the use of a common telescope, he begins to suspect that all the milkiness of the bright path which surrounds the sphere may be owing to stars. By increasing his power of vision, he becomes certain that the milky way is, indeed, no other than a collection of very small stars, and the nebulæ nothing but clusters of stars.

Dr. Herschel then solves a general problem for computing the length of the visual ray: that of the telescope, which he uses, will reach to stars 497 times the distance of Sirius. Now, according to the Doctor's reasoning, Sirius cannot be nearer than $100{,}000 \times 194{,}000{,}000$ miles; therefore his telescope will, at least, reach to $100{,}000 \times 194{,}000{,}000 \times 497$ miles. And Dr. Herschel says, that in the most crowded part of the milky way he has had fields of view that contained no less than 588 stars, and these were continued for many minutes, so that, in a quarter of an hour, he has seen 116,000 stars pass through the field view of a telescope of only 15′ aperture: and at another time, in 41 minutes, he saw 258,000 stars pass through the field of his telescope. Every improvement in his telescopes has discovered stars not seen before, so that there appears no bounds to their number, or to the extent of the universe.

The sun, like many other stars, has probably a progressive motion, directed towards the constellation Hercules. Dr. Herschel, on this subject, observes, that the apparent proper motions of 44 stars out of 56 are nearly in the direction which would be the result of such a real motion of the solar system; and that the bright stars Arcturus and Sirius, which are brobably the nearest to us, have, as they ought, according to this theory, the greatest apparent motions. Again, the star Castor appears, when viewed with a telescope, to consist of two stars, of nearly equal magnitude; and though they have both an apparent motion, they have never been found to change their distance with respect to one another a single second, a circumstance which is easily understood, if both their apparent motions are supposed to arise from the real motion of the sun.

The sun revolves on his axis in $25^d\ 10^h$, with respect to the fixed stars; this axis is directed towards a point, about half

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way between the pole star and Lyra, the plane of the rotation being inclined a little more than 7° to that in which the earth revolves. The direction of this motion is from west to east. All the rotations of the different bodies which compose the solar system, as far as they have been ascertained, are in the same direction, and likewise all their revolutions, excepting those of some of the comets, and those of some of the satellites of the Herschel planet.

The time and the direction of the sun's rotation are ascertained by the change of the situation of the spots, which are usually visible on his disc, and which some astronomers supposed to be elevations, and others to be excavations in the luminous matter covering the sun's surface. These spots are frequently observed to appear and disappear, and they are in the mean time liable to great variations, though they are generally found about the same points of the sun's surface. M. Lalande supposes them to be parts of the solid body of the sun, which by some agitations of the luminous ocean with which he conceives the sun to be surrounded, are left nearly or entirely bare. Dr. Wilson and Dr. Herschel are disposed to consider this ocean as consisting rather of a flame than of a liquid substance; and Dr. Herschel, in an ingenious paper, attributes the spots to the emission of an æriform fluid, not yet in combustion, which displaces the general luminous atmosphere, and which is afterwards to serve for fuel for supporting the process; hence he supposes the appearance of copious spots to be indicative of the approach of warm seasons on the surface of the earth, a theory which he has attempted to maintain by historical evidence. The exterior luminous atmosphere has an appearance somewhat mottled; some parts of it, appearing brighter than others, have been called faculæ; but Dr. Herschel distinguishes them by the names of ridges and nodules. The spots are usually surrounded by margins less dark than themselves, which are called shallows, and which are considered as parts of an inferior stratum, consisting of opaque clouds, capable of protecting the immediate surface of the sun from the excessive heat produced by combustion in the superior stratum, and perhaps rendering it habitable to animated beings.

To which Dr. Young replies, if we inquire into the intensity of the heat which must necessarily exist wherever this combustion is performed, we shall soon be convinced that no clouds, however dense, could impede its rapid transmission to the parts below. Besides, the diameter of the sun is 111 times as great as that of the earth; and at its surface, a heavy body would fall through no less than 450 feet in a single second; so that if every other circumstance permitted human beings to reside on it, their own weight would present an insuperable difficulty, since it would become thirty times as great as upon the surface of the earth, and a man of moderate size would weigh above two tons.

Dr. Herschel, in another paper, supposes that the spots in the sun are mountains on its surface, which, considering the great attraction exerted by the sun upon bodies placed at its surface, and the slow revolution it has about its axis, he thinks may be more than 300 miles high, and yet stand very firmly. He says, that in August 1792, he examined the sun with several powers, from 90 to 500. And it evidently appeared that the black spots are the opaque ground or body of the sun; and that the luminous part is an atmosphere, which, being intercepted or broken, gives us a glimpse of the sun itself. Hence he concludes that the sun has a very extensive atmosphere, which consists of elastic fluids that are more or less lucid and transparent; and of which the lucid ones furnish us with light. This atmosphere he thinks is not less than 1843 nor more than 2765 miles in height; and he supposes that the density of the luminous solar clouds need not be exceedingly more than that of our aurora borealis, in order to produce the effects with which we are acquainted.

The sun, then, appears to be a very eminent, large, and lucid planet, evidently the first and only primary one belonging to our system. Its similarity to the other globes of the solar system, with regard to its solidity; its atmosphere; its surface diversified with mountains and vallies; its rotation on its exis; and the fall of heavy bodies on its surface; leads us to suppose that it is most probably inhabited, like the rest of the planets, by beings whose organs are adapted to the peculiar circumstances of that vast globe. If it be objected that, from the effects produced at the distance of 95,000,000 miles, we may infer that every thing must be scorched up at its surface; we reply, that there are many facts in natural philosophy, which show that heat is produced by the sun's rays only when they

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act on a calorific medium: they are the cause of the production of heat, by uniting with the matter of fire which is contained in the substances that are heated; as the collision of the flint and steel will inflame a magazine of gunpowder, by putting all the latent fire which it contains into action. On the tops of mountains of sufficient height, at the altitude where clouds can seldom reach to shelter them from the direct rays of the sun, we always find regions of ice and snow. Now, if the solar rays themselves conveyed all the heat we find on this globe, it ought to be hottest where their course is the least interrupted. Again, our aëronauts all confirm the coldness of the upper regions of the atmosphere; and since, therefore, even on our earth, the heat of the situation depends upon the readiness of the medium to yield to the impression of the solar rays, we have only to admit, that on the sun itself the elastic fluids composing its atmosphere, and the matter on its surface, are of such a nature as not to be capable of any extensive affection of its own rays; and this seems to be proved by the copious emission of them; for if the elastic fluids of the atmosphere, or of the matter contained on the surface of the sun, were of such a nature as to admit of an easy chemical combination with its rays, their emission would be very much impeded. Another well known fact is, that the solar focus of the largest lens thrown into the air will occasion no sensible heat in the place where it has been kept for a considerable time, although its power of exciting combustion, when proper bodies are exposed, should be sufficient to fuse the most refractory substances.

It is by analogical reasoning that we consider the moon as inhabited. For it is a secondary planet of considerable size, its surface is diversified like that of the earth with hills and vallies. Its situation with respect to the sun is much like that of the earth; and by a rotation on its axis it enjoys an agreeable variety of seasons, and of day and night. To the moon our globe would appear a capital satellite, undergoing the same changes of illumination as the moon does to the earth. The sun, planets, and the starry constellations of the heavens, will rise and set there as they do here: and heavy bodies will fall on the moon as they do on the earth. There seems, then, only to be wanting, in order to complete the analogy, that it should be inhabited like the earth. It may be objected, that, in the moon, there are no large seas; and its atmosphere (the existence of which is doubted by many) is extremely rare, and unfit for the purposes of animal life; that its climates, its seasons, and the length of its days and nights, totally differ from ours; that without dense clouds, which the moon has not, there can be no rain, perhaps no rivers and lakes. In answer to this it may be observed, that the very difference between the two planets strengthens the argument. We find, even on our own globe, that there is a most striking dissimilarity in the situation of the creatures that live upon it. While man walks on the ground, the birds fly in the air, and the fishes swim in the water. We cannot surely object to the conveniencies afforded by the moon, if those that are to inhabit its regions are fitted to their conditions as well as we on this globe of ours. The analogy already mentioned establishes a high probability that the moon is inhabited.

Suppose, then, an inhabitant of the moon, who has not properly considered such analogical reasonings as might induce him to surmise that our earth is inhabited, were to give it as his opinion, that the use of that great body, which he sees in his neighbourhood, is to carry about his little globe, in order that it may be properly exposed to the light of the sun, so as to enjoy an agreeable and useful variety of illumination, as well as to give it light by reflection, when direct light cannot be had, should we not condemn his ignorance and want of reflection? The earth, it is true, performs those offices which have been named for the inhabitants of the moon, but we know that it also affords magnificent dwelling-places to numberless intelligent beings. From experience, therefore, we affirm, that the performance of the most salutary offices to inferior planets is not inconsistent with the dignity of superior purposes; and in consequence of such analogical reasonings, assisted by telescopic views which plainly favour the same opinion, we do not hesitate to admit that the sun is richly stored with inhabitants.

This way of considering the sun is of the utmost importance in its consequences. That stars are suns can hardly admit of a doubt. Their immense distance would effectually exclude them from our view, if their light were not of the solar kind. Besides, the analogy may be traced much further; the sun turns on its axis; so does the star Algol; so do the stars called β Lyræ, δ Cephei, η Antinoi, ο Ceti, and

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many more, most probably all. Now from what other cause can we, with so much probability, account for their periodical changes? Again, our sun's spots are changeable; so are the spots on the star *o* Ceti. But if stars are suns, and suns are inhabitable, we see at once what an extensive field for animation opens to our view.

It is true, that analogy may induce us to conclude, that since stars appear to be suns, and suns, according to the common opinion, are bodies that serve to enlighten, warm, and sustain a system of planets, we may have an idea of numberless globes that serve for the habitation of living creatures. But if these suns themselves are primary planets, we may see some thousands of them with the naked eyes, and millions with the help of telescopes; and, at the same time, the same analogical reasoning still remains in full force with regard to the planets which these suns may support. See Philosophical Transactions, and Young's Natural Philosophy.

We shall conclude this article with some particulars respecting the sun, by Sir Isaac Newton. 1. That the density of the sun's heat, which is proportional to his light, is 7 times as great in Mercury as with us, and that water there would be all carried off in the shape of steam; for he found, by experiments with the thermometer, that a heat seven times greater than that of the sun's beams in summer will serve to make water boil. 2. That the quantity of matter in the sun is to that in Jupiter nearly as 1100 to 1, and that the distance of that planet from the sun is in the same ratio to the sun's semidiameter; consequently, that the centre of gravity of the sun and Jupiter is nearly in the superficies of the sun. 3. That the quantity of matter in the sun is to that in Saturn as 2360 to 1, and that the distance of Saturn from the sun is in a ratio but little less than that of the sun's semidiameter. And hence the common centre of gravity of Saturn and the sun is a little within the sun. 4. By the same method of calculation it will be found, that the common centre of gravity of all the planets cannot be more than the length of the solar diameter distant from the centre of the sun. 5. The sun's diameter is equal to 100 diameters of the earth, and therefore its magnitude must exceed that of the earth one million of times. 6. If 360 degrees (the whole ecliptic) be divided by the quantity of the solar year, it will give 59′ 8″, which therefore is the medium quantity of the sun's apparent daily motion; hence his horary motion is equal to 2′ 27″. By this method the tables of the sun's mean motion are constructed as found in astronomical books.

SUPERCARGO, a person employed by merchants to go a voyage, and oversee their cargo of lading, and dispose of it to the best advantage.

SUPERFICIES, or Surface, in geometry, a magnitude considered as having two dimensions; or extended in length and breadth, but without thickness or depth. In bodies, the superficies is all that presents itself to the eye. A superficies is chiefly considered as the external part of a solid. When we speak of a surface simply, and without any regard to body, we usually call it figure. The several kinds of superficies are as follow: rectilinear superficies, that comprehended between right lines; curvilinear superficies, that comprehended between curve lines; plane superficies, is that which has no inequality, but lies evenly between its boundary lines; convex superficies, is the exterior part of a spherical or spheroidical body; and a concave superficies, is the internal part of an orbicular or spheroidical body.

The measure or quantity of a superficies, or surface, is called the area thereof.

The finding of this measure, or area, is called the quadrature thereof.

To measure the surfaces of the several kinds of bodies, as spheres, cubes, parallelopipeds, pyramids, prisms, cones, &c.

Superficies, *line of*, a line usually found on the sector, and Gunter's scale, the description and use whereof, see under Sector, and Gunter's *scale*.

SUPERLATIVE, in grammer, one of the three degrees of comparison, being that inflection of nouns adjective that serves to augment and heighten their signification, and shows the quality of the thing denoted to be in the highest degree.

SUPERNUMERARY, something over and above a fixed number. In several of the offices are supernumerary clerks, to be ready on extraordinory occasions. There are also supernumerary surveyors of the excise, to be ready to supply vacancies when they fall; these have but half pay.

SUPERSEDEAS, a writ that lies in a great many cases, and signifies, in general, a command to stay proceedings.

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on good cause shown, which ought otherwise to proceed. By a supersedeas, the doing of a thing, which might otherwise have been lawfully done, is prevented; or a thing that has been done, is (notwithstanding it was done in a due course of law) thereby made void. A supersedeas is either expressed or implied; an express supersedeas is sometimes by writ, sometimes without a writ; where it is by writ, some person, to whom the writ is directed, is thereby commanded to forbear the doing something therein mentioned; or, if the thing has been already done, to revoke, as that can be done, the act.

A person is superseded out of prison, when, by the practice of the court, the plaintiff has omitted to proceed in due time against him.

SUPPLEMENT *of an arch*, in geometry, or trigonometry, is the number of degrees that it wants of being an entire semicircle; as a complement signifies what an arch wants of being a quadrant.

SUPPORTED, in heraldry, a term applied to the uppermost quarters of a shield when divided into several quarters, these seeming as it were supported or sustained by those below. The chief is said to be supported when it is of two colours, and the upper colour takes up two-thirds of it. In this case it is supported by the colour underneath.

SUPPORTERS, in heraldry, figures in an achievement placed by the side of the shield, and seeming to support or hold up the same. Supporters are chiefly figures of beasts: figures of human creatures, for the like purpose, are properly called tenants. Some make another difference between tenant and supporter: when the shield is borne by a single animal, it is called tenant; when by two, they are called supporters. The figures of things inanimate, sometimes placed aside of escutcheons, but not touching or seeming to bear them, though sometimes called supporters, are more properly cotises. The supporters of the British arms are a lion and an unicorn. In England, none under the degree of a banneret are allowed supporters, which are restrained to those called the high nobility. The Germans permit none but princes and noblemen of rank to bear them; but among the French, formerly, the use of them was more promiscuous.

SUPPRESSION, in grammar and rhetoric, denotes an omission of certain words in a sentence, which yet are necessary to full and perfect construction: as, "I come from my father's;" that is, "from my father's house." Suppression is a figure of speech very frequent in our language, chiefly used for brevity and elegance. Some rules relating thereto are as follow: 1. Whenever a word comes to be repeated in a sentence oftener than once, it is to be suppressed. Thus, we say, "This is my master's horse," not "This horse is my master's horse." 2. Words that are necessarily supplied may be suppressed: and, 3. All words that use and custom suppress in other languages, are also to be suppressed in English, unless there be particular reasons for the contrary.

Suppression is also a figure in speech, whereby a person in rage, or other disturbance of mind, speaks not out all he means, but suddenly breaks off his discourse. Thus the gentleman in Terence, extremely incensed against his adversary, accosts him with this abrupt saying, "Thou of all." The excess of his indignation and rage choked the passage of his voice, and would not suffer him to utter the rest. But in these cases, though the discourse is not complete, the meaning is readily understood, and the evidence of the thought easily supplies the defect of words. Suppression sometimes proceeds from modesty, and fear of uttering any word of ill and offensive sound.

SURD, in arithmetic and algebra, denotes any number or quantity that is incommensurable to unity; otherwise called an irrational number or quantity.

The square roots of all numbers, except 1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, &c. (which are the squares of the integer numbers, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, &c.) are incommensurables: and after the same manner the cube roots of all numbers, but of the cubes of 1, 2, 3, 4, 5, 6, &c. are incommensurables; and quantities that are to one another in the proportion of such numbers must also have their square roots, or cube roots, incommensurable.

The roots, therefore, of such numbers, being incommensurable, are expressed by placing the proper radical sign over them: thus $\sqrt[2]{2}$, $\sqrt[2]{3}$, $\sqrt[2]{5}$, $\sqrt[2]{6}$, &c. express numbers incommensurable with unity. However, though these numbers are incommensurable themselves with

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unity, yet they are commensurable in power with it; because their powers are integers, that is, multiples of unity. They may also be commensurable sometimes with one another, as the $\sqrt[2]{8}$ and $\sqrt[2]{2}$; because they are to one another as 2 to 1: and when they have a common measure, as $\sqrt[2]{2}$ is the common measure of both; then their ratio is reduced to an expression in the least terms, as that of commensurable quantities, by dividing them by their greatest common measure. This common measure is found, as in commensurable quantities; only the root of the common measure is to be made their common divisor: thus $\frac{\sqrt{12}}{\sqrt{3}} = \sqrt{4} = 2$, and $\frac{\sqrt{18a}}{\sqrt{2}} = 3\sqrt{a}$.

A rational quantity may be reduced to the form of any given surd, by raising the quantity to the power that is denominated by the name of the surd, and then setting the radical sign over it: thus $a = \sqrt[2]{a^2} = \sqrt[3]{a^3} = \sqrt[4]{a^4} = \sqrt[5]{a^5} = \sqrt[n]{a^n}$, and $4 = \sqrt{16} = \sqrt[3]{64} = \sqrt[4]{256} = \sqrt[5]{1024} = \sqrt[n]{4^n}$.

As surds may be considered as powers with fractional exponents, they are reduced to others of the same value, that shall have the same radical sign, by reducing these fractional exponents to fractions having the same value and a common denominator.

Thus $\sqrt[n]{a} = a^{\frac{1}{n}}$, and $\sqrt[m]{a} = a^{\frac{1}{m}}$, and $\frac{1}{n} = \frac{m}{nm}$, $\frac{1}{m} = \frac{n}{nm}$, and therefore $\sqrt[n]{a}$ and $\sqrt[m]{a}$, reduced to the same radical sign, become $\sqrt[nm]{a^m}$ and $\sqrt[nm]{a^n}$. If you are to reduce $\sqrt[2]{3}$ and $\sqrt[3]{2}$ to the same denominator, consider $\sqrt[2]{3}$ as equal $3^{\frac{1}{2}}$, and $\sqrt[3]{2}$ as equal to $2^{\frac{1}{3}}$, whose indices, reduced to a common denominator, you have $3^{\frac{1}{2}} = 3^{\frac{3}{6}}$, and $2^{\frac{1}{3}} = 2^{\frac{2}{6}}$, and consequently, $\sqrt[2]{3} = \sqrt[6]{3^3}, = \sqrt[6]{27}$, and $\sqrt[3]{2} = \sqrt[6]{2^2} = \sqrt[6]{4}$; so that the proposed surds $\sqrt[2]{3}$ and $\sqrt[3]{2}$, are reduced to other equal surds $\sqrt[6]{27}$ and $\sqrt[6]{4}$, having a common radical sign.

Surds of the same rational quantity are multiplied by adding their exponents, and divided by subtracting them: thus, $\sqrt[2]{a} \times \sqrt[3]{a} = a^{\frac{1}{2}} \times a^{\frac{1}{3}} a = a^{\frac{3+2}{6}} = a^{\frac{5}{6}} = \sqrt[6]{a^5}$; and $\frac{\sqrt[3]{a}}{\sqrt[5]{a}} = \frac{a^{\frac{1}{3}}}{a^{\frac{1}{5}}} = a^{\frac{1}{3}-\frac{1}{5}} = a^{\frac{5-3}{15}} = a^{\frac{2}{15}} = \sqrt[15]{a^2}$; $\sqrt[m]{a} \times \sqrt[n]{a} = a^{\frac{m+n}{mn}}$; $\frac{\sqrt[m]{a}}{n} = a^{\frac{n-m}{mn}}$; $\sqrt[2]{2} \times \sqrt[3]{2} = \sqrt{2^5} = \frac{\sqrt{a}}{\sqrt[6]{32}}$; $\frac{\sqrt[2]{2}}{\sqrt[3]{2}} = \sqrt[6]{2}$.

If the surds are of different rational quantities, as $\sqrt[n]{a^2}$ and $\sqrt[n]{b^3}$, and have the same sign, multiply these rational quantities into one another, or divide them by one another, and set the common radical sign over their product, or quotient. Thus $\sqrt[n]{a^2} \times \sqrt{b^3} = \sqrt[n]{a^2 b^3}$; $\sqrt[2]{2} \times \sqrt[3]{5} = \sqrt[2]{10}$; $\frac{\sqrt[m]{a^4}}{\sqrt[m]{b^3 a}} = \sqrt[m]{\frac{a^4}{b^3 a}} = \sqrt[m]{\frac{a^3}{b^3}} \frac{\sqrt[3]{9}}{\sqrt[3]{24}} = \sqrt[3]{\frac{9}{24}} = \sqrt{\frac{3}{8}} = \frac{1}{2}\sqrt[2]{3}$.

If surds have not the same radical sign, reduce them to such as shall have the same radical sign, and proceed as before: $\sqrt[m]{a} \times \sqrt[n]{b} = \sqrt[nm]{a^n b^m}$; $\frac{\sqrt[m]{a}}{\sqrt[n]{x_1}} = \sqrt[mn]{\frac{a^n}{x^m}}$; $\sqrt[2]{2} \times \sqrt[3]{4} = 2^{\frac{1}{2}} \times 4^{\frac{1}{3}} = \sqrt[6]{2^3} \times 4^2 = \sqrt[6]{8} \times 16 = \sqrt[6]{128}$; $\frac{\sqrt[3]{4}}{\sqrt[2]{2}} = \frac{4^{\frac{1}{3}}}{2^{\frac{1}{2}}} = \frac{4^{\frac{2}{6}}}{2^{\frac{3}{6}}} = \sqrt[6]{\frac{4^2}{2^3}} = \sqrt[6]{\frac{16}{8}} = \sqrt[6]{2}$.

If the surds have any rational coefficients, their product or quotient must be prefixed; thus, $2\sqrt[2]{3} \times 5\sqrt[2]{6} = 10\sqrt[2]{18}$. The powers of surds are found as the powers of their quantities, by multiplying their exponents by the index of the power required; thus the square of $\sqrt[3]{2}$ is $2^{\frac{1}{3} \times 2} = 2^{\frac{2}{3}} = \sqrt[3]{4}$; the cube of $\sqrt[2]{5} = 5^{\frac{1}{4} \times 3} = 5^{\frac{3}{4}} = \sqrt[4]{125}$ Or you need only, in involving surds, raise the quantity under the radical sign to the power required, continuing the same radical sign; unless the index of that power is equal to the name of the surd, or a multiple of it, and in that case the power of the surd becomes rational. Evolution is performed by dividing the fraction, which is the exponent of the surd, by the name of the root required. Thus, the square root of $\sqrt[3]{a^4}$ is $\sqrt[3]{a^4}$ or $\sqrt[6]{a^4}$.

The surd $\sqrt[m]{ax} = a\sqrt[m]{x}$; and, in

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like manner, if a power of any quantity of the same name with the surd divides the quantity under the radical sign without a remainder, as here a^m divides $a^m x$, and 25, the square of 5, divides 75, the quantity under the sign in $\sqrt[2]{75}$, without a remainder; then place the root of that power rationally before the sign, and the quotient under the sign, and thus the surd will be reduced to a more simple expression. Thus, $\sqrt[2]{75} = 5\sqrt{3}$; $\sqrt[2]{48} = \sqrt[2]{3 \times 16} = 4\sqrt[2]{3}$; $\sqrt[3]{81} = \sqrt[3]{27 \times 3} = 3\sqrt[3]{3}$.

When surds are reduced to their least expressions, if they have the same irrational part, they are added or subtracted, by adding or subtracting their rational coefficients, and prefixing the sum or difference to the common irrational part. Thus, $\sqrt[2]{75} + \sqrt[2]{48} = 5\sqrt{3} + 4\sqrt{3} = 9\sqrt{3}$; $\sqrt[3]{81} + \sqrt[3]{24} = 3\sqrt[3]{3} + 2\sqrt[3]{3} = 5\sqrt[3]{3}$; $\sqrt[2]{150} - \sqrt[2]{54} = 5\sqrt{6} - 3\sqrt{6} = 2\sqrt{6}$; $\sqrt{a^2 x} + \sqrt{b^4 x} = a\sqrt{x} + b\sqrt{x} = \overline{a + b} \times \sqrt{x}$.

Compound surds are such as consist of two or more joined together; the simple surds are commensurable in power, and by being multiplied into themselves, give at length rational quantities; yet compound surds, multiplied into themselves, commonly give still irrational products. But when any compound surd is proposed, there is another compound surd, which, multiplied into it, gives a rational product. Thus, if $\sqrt{a} + \sqrt{b}$ were proposed, multiplying it by $\sqrt{a} - \sqrt{b}$, the product will be $a - b$.

The investigation of that surd, which, multiplied into the proposed surd, gives a rational product, is made easy by three theorems, delivered by Mr. Maclaurin, in his Algebra.

This operation is of use in reducing surd expressions to more simple forms. Thus, suppose a binomial surd divided by another, as $\sqrt[2]{20} + \sqrt[2]{12}$, by $\sqrt[2]{5} - \sqrt[2]{3}$, the quotient might be expressed by $\frac{\sqrt{20} + \sqrt{12}}{\sqrt{5} - \sqrt{3}}$. But this might be expressed in a more simple form, by multiplying both numerator and denominator by that surd, which, multiplied into the denominator, gives a rational product: thus, $\frac{\sqrt{20} + \sqrt{12}}{\sqrt{5} - \sqrt{3}} = \frac{\sqrt{20} + \sqrt{12}}{\sqrt{5} - \sqrt{3}} + \frac{\sqrt{5} + \sqrt{3}}{\sqrt{5} + \sqrt{3}} = \frac{\sqrt{100} + 2\sqrt{60} + 6}{5 - 3} = \frac{15 + 2\sqrt{60}}{2} = 8 + 2\sqrt{15}$.

When the square root of a surd is required, it may be found, nearly, by extracting the root of a rational quantity that approximates to its value. Thus, to find the square root of $3 + 2\sqrt{2}$, first calculate $\sqrt{2} = 1{,}41421$. Hence $3 + 2\sqrt{2} = 5{,}82842$, the root of which is found to be nearly 2,41421.

In like manner we may proceed with any other proposed root. And if the index of the root proposed to be extracted be great, a table of logarithms may be used. Thus, $\sqrt[7]{5 + \sqrt[13]{17}}$ may be most conveniently found by logarithms.

Take the logarithm of 17, divide it by 13; find the number corresponding to the quotient; add this number to 5: find the logarithm of the sum, and divide it by 7, and the number corresponding to this quotient will be nearly equal to $\sqrt[7]{5 + \sqrt[13]{17}}$.

But it is sometimes requisite to express the roots of surds exactly by other surds. Thus, in the first example, the square root of $3 + 2\sqrt{2}$ is $1 + \sqrt{2}$: for $\overline{1 + \sqrt{2}} \times \overline{1 + \sqrt{2}} = 1 + 2\sqrt{2} + 2 = 3 + 2\sqrt{2}$. For the method of performing this, the curious may consult Mr. Maclaurin's Algebra.

SURETY *of the peace.* A justice of the peace may, according to his discretion, bind all those to keep the peace who, in his presence, shall make any affray, or shall threaten to kill or beat any person, or shall contend together in hot words; and all those who shall go about with unlawful weapons, or attendance, to the terror of the people; and all such persons as shall be known by him to be common barrators; and all who shall be brought before him by a constable, for a breach of the peace in the presence of such constable; and all such persons, who, having been before bound to keep the peace, shall be convicted of having forfeited their recognisance. When surety of the peace is granted by the Court of King's Bench, if a supersedeas come from the Court of Chancery to the justices of that court, their power is at an end, and the party as to them discharged.

If surety of the peace be desired against a peer, the safest way is to apply to the Court of Chancery or King's Bench. If the person against whom security of the peace be demanded be present, the justice of the peace may commit him immediately, unless he offer sureties; and à

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fortiori he may be commanded to find sureties, and be committed for not doing it.

SURGERY is that division of the healing art, which is chiefly conversant with the treatment of the external and local disorders of the body, of the effects of accidental injury, and of such diseases in general as are curable by manual operation. Yet its field is not entirely confined to the department just alluded to; since local disorders, and particularly accidents, often affect the whole frame, so as to induce a general derangement of the constitution; and again, diseases of parts arise out of constitutional affections, or, although originally independent, may be greatly aggravated by them. Hence it is obviously necessary that the surgeon should be acquainted with the nature and treatment of such general disorders; and consequently, in marking out the limits which divide the departments of the surgeon and physician, it is hardly possible to attain such a pitch of accuracy, as to prevent all supposed encroachment of either side on the province of the other.

The care of the external and local affections of the human body was, in the infancy of science, a branch of the art of medicine. Surgery and physic were then, and for many ages afterwards, practised by the same individuals. These, however, in course of time, began to consider the manual and operative part of the profession as too mechanical and low for persons of their scientific education, and consequently resigned them to an inferior class of uneducated men, who generally combined with them the trade of the barber. Hence arose, in most countries of Europe, the calling of barber-surgeon; which included, besides shaving, hairdressing, &c. tooth-drawing, bleeding, dressing of ulcers, and other of the more common and easy parts of operative surgery. While contaminated by so degrading an alliance, and practised by persons wholly illiterate, we cannot be surprised to find that surgery and its professors met with neglect and contempt, and that the latter were considered as merely subordinate to the physicians. The barber-surgeons must still have had opportunities of seeing and learning disease; they began to get an insight into the structure of the human body, and they acquired a respectability, by being employed in wars in the cure of the wounded. The physicians, who were still the only regularly educated and scientific class of men practising the art of healing, wished to retain their old and long enjoyed superiority; and hence arose in many countries long and sharp disputes with the barber-surgeons, which ended at last, as the progress of civilization and improvement would naturally lead us to expect, in the separation of the barbers and surgeons, and the elevation of the latter to their proper rank and consideration in society.

Whatever part of the subject we may contemplate, we shall find that the art of surgery requires, no less than that of physic, all the advantages that can be derived from the most liberal education; that it demands still more imperiously a familiar knowledge of anatomy and physiology, *i. e.* of the structure and functions of that machine, whose derangements it proposes to remedy; and consequently, that although prejudice still assigns to the physician a superior rank to that of the surgeon, they must be considered, in modern days, as equals, whether we regard the reason of the thing, or proceed to an actual comparison of individuals.

Our opinions concerning the education and qualifications of the surgeon will be easily collected from the foregoing observations. Instead of spending seven years of the most valuable part of his life in the drudgery of an apothecary's shop, the youth destined for the profession of surgery should receive a learned and liberal education. The Latin language among the dead, and the French of the living, are indispensably necessary; and the German would form a very useful addition to these.

Anatomy and physiology are the next objects of attention, and demand the most assiduous cultivation; these sciences are the foundation on which the art of surgery rests. The study of chemistry and natural philosophy will be pursued at the same time. When prepared by these previous steps, the student may commence the practical part of his education in the large hospitals of the metropolis; carefully studying diseases themselves, taking notes of the most interesting cases, and omitting no opportunity of observing the alterations occasioned by disease in the structure of the body.—Lectures on surgery, on the materia medica, and the practice of medicine, must also be attended. The performance of surgical operations on the dead body will be highly beneficial, as leading to the study of those parts of anatomy, which are more particularly concerned in operations, and as imparting the manual skill necessary to the operator.

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SURGERY.

Of systematic works on surgery, there is none which unites the recommendations of clearness, shortness, and comprehension, to so great a degree, as the "First lines of the Practice of Surgery," by Mr. S. Cooper, to which we therefore refer the reader. The larger systems are by no means unexceptionable; we may mention that of Latta; the "Systema Chirurgiæ hodiernæ" of Callisen; and the "Anfangs-grunde der Wundarzney kunst" of Richter. Generally, however, the works that treat of particular subjects are to be preferred to the systems of surgery. The writings of Mr. Pott, and the "Memoirs of the French Royal Academy of Surgery, contain a great deal of valuable information; as also do those of John Hunter, Home, Abernethy, and Astley Cooper; Le Dran, Sharp, Bertrandi, and Sabatier, may be read on the operations. The numerous other sources of surgical knowledge will be discovered by the student in his progress. The following sketch will be divided into general surgical subjects, or such disorders as are common to several situations in the body, including also the constitutional derangements which accompany or cause local disorders; and particular surgical subjects, or the disorders and injuries of each particular part, and the operations practised on it. As the limits between surgery and medicine are rather artificial than real, these two branches of medical science touch each other in various points, and the physician and surgeon both claim a right to undertake the management of the same disorder. Hence the article MEDICINE of this work contains remarks on several diseases which are often treated by the surgeon; and we refer the reader to that article on the following points, *viz.* fever, tetanus, rachitis, scrofula, amaurosis, albugo, deafness, enuresis, ischuria, herpes, tinea, and psora.

GENERAL SURGICAL SUBJECTS.

Sympathetic Fever. No part of the animal body can be very considerably disordered, without occasioning a correspondent derangement of the whole constitution. Such disorder has been considered by Mr. Hunter as the result of universal sympathy. This consent of the whole constitution with its parts manifests itself in particular instances, by a greater disturbance of the functions of some organs than of others; and from this circumstance these diseases have derived the appellations by which they are commonly distinguished. If the actions of the sanguiferous system be principally disturbed, and the temperature of the body subject to unnatural variations, the disease is termed fever; if the nervous system be chiefly affected, a state of vigilance or delirium may be produced; convulsions and tetanus take place, when the muscular system is more particularly disordered. Though the especial disorder of particular organs thus gives a character and denomination to the disease, it is sufficiently evident, in every instance, that the whole constitution is disturbed.

The fever which accompanies local accident or disease has been termed symptomatic, as if it were one of the symptoms of the local disorder; the epithet sympathetic is preferable, as it is founded on the real nature of the disorder, *viz.* a sympathy of the whole constitution for the disturbed state of a part.

The sympathetic inflammatory fever is accompanied with a frequent, strong and full pulse, hot and dry skin, scanty and high coloured urine, dry furred tongue, thirst, loss of appetite and sleep: in some cases delirium.

When the local affection is in such parts as are essential to life, the powers of the constitution seem to be much depressed; and the pulse is frequent and small.

Treatment. The cure of the local inflammation which excites and keeps up this sympathetic disturbance of the whole constitution, is the most effectual step for stopping the general disorder. But as the fever may react on the local disorder, palliative means may be necessary for the constitutional symptoms. Bleeding, saline purgatives, and diaphoretics, as the preparations of antimony, and the aqua ammoniæ acetatæ, are the best means. The use of the lancet is only advisable where the local mischief is to be feared on account of its situation or extent.

The sympathetic fever, just described, is produced by the irritation of a local injury upon a healthy constitution; when, however, the disease has continued unsubdued for a long time, the constitution still sympathizes, although in a different manner; and the disorder then produced is called the sympathetic hectic fever. This form of constitutional sympathy attends such local affections as debilitate and harass the frame; and it is the reactive effort of an irritated and weakened constitution. The symptoms are, a frequent, small pulse, moist skin, pale and

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copious urine, great weakness, moist tongue, deficient appetite, often sickness, nocturnal sweats, loss of sleep, indigestion, &c.

Treatment. The alleviation or removal of the local complaint is the most effectual remedy. When this cannot be accomplished, we must try to strengthen the patient; and if there were a medicine possessing the direct power of communicating strength to the constitution, these cases would be very proper for its employment. Particular symptoms may be combatted, so as to keep all the functions in a state approaching as nearly as we can to that of health, and digestion promoted. Bark, with gentle cordial and aromatic draughts, are the most proper medicines. The food should be light and nourishing, and taken frequently in small quantities. Opium is often of great service, both in procuring sleep, and in checking the purging.

Disorder of the digestive Organs. The stomach and bowels bear a considerable share in the sympathetic derangements already considered. But in many instances of local complaints they are deranged in a still more striking way; and again, a disturbed state of these organs, arising from various causes, will either give origin to various obstinate local complaints, or very much increase the difficulty of their cure. Many observations connected with this subject are scattered in the works of surgical writers; but the public are indebted for a general, scientific, and original view of the whole subject, to Mr. Abernethy; to whose surgical observations we must refer the reader.

The symptoms of disordered digestive organs, whether induced by the irritation of local disease, or by other causes, as sedentary life, impure air, anxiety, and too great exertion of mind or body, are, diminution of the appetite and digestion, flatulence, and unnatural colour and fetor of the excretions, which are generally deficient in quantity. The tongue is dry, whitish, and furred, particularly at the back part, and this symptom is most apparent in the morning. As the disease advances, a tenderness is felt on pressing the epigastric region, and the urine is frequently turbid. Mr. Abernethy considers this affection to be a general disorder of all the organs concerned in the assimilation of our food; and that it consists in a weakness and irritability of the affected parts, accompanied by a deficiency or depravity of the fluids secreted by them; upon the healthy qualities of which the right performance of their functions seems to depend. The duration of the affection without fatal consequences, or indeed without any changes of structure in the parts, shows that it is only a disorder of functions.

When it is considered that this derangement of the chylopoietic viscera may bring on various diseases, and that local affections, occurring during its existence, will become peculiar in their nature and progress, and difficult of cure, the importance of the subject will be readily allowed. A particular attention to diet is a point of primary importance in the treatment; and connected with this, the practice of taking five grains of powdered rhubarb an hour before dinner is very beneficial. A correction of any obvious irregularity in the intestines, and a regular diurnal evacuation of them, are the next points to which we must attend. Purging is by no means advisable in the weakened state of these organs. The administration of small doses of mercury every night, or every other night, has a powerful effect in correcting disorders of the biliary secretion, and consequently in bringing the stools to their natural colour. Vegetable diet drinks, as the decoct. sarsaparill. comp. have been advantageously combined with these means. The cause of the disorder may be more completely relieved by good air, exercise, and mental tranquillity, while the medical assistance above mentioned counteracts the effects. By such simple treatment as we have just mentioned, obstinate and extensive local diseases of the most opposite classes, which have resisted all the ordinary methods, will often be either entirely cured, or very signally relieved.

Tetanus, or lock jaw, is one of the most alarming consequences of local injury. It is most frequent in warm climates, in the male sex, and in the robust and vigorous. It does not appear till many days after the accident, and frequently when the wound is quite healed. Injuries of the fingers and toes are its most frequent causes.

Symptoms. The muscles of the lower jaw first become stiff, and then rigidly contracted, so that the mouth cannot be opened. Those of the neck, back, and whole body, are successively affected in the same manner. The spasm, however, is not constant, as violent and most painful convulsions occasionally agitate the whole frame. The progress is various;

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when rapid, the patient scarcely ever recovers; but if he survive the fourth day, the prognostic is much more favourable. The vital functions are but little affected.

Treatment. When the symptoms have come on, there seems to be no connection between them and the original local cause; so that no assistance can be derived from this source. Opium in very large doses, as a grain in two hours, and then gradually increased; and the same remedy by the way of clyster, and in frictions, seems to have afforded the most relief. The warm bath, camphor, volatile alkali, and musk, according to circumstances. Large quantities of wine have been recommended; and in some cases the cold bath during the spasm has relieved. Salivation is useless.

Inflammation, in some of its states or varieties, is presented to our view in almost every surgical disease, and consequently particularly demands the attention of the surgeon. It occurs as a natural means of cure in many species of accidental injury; and here it is considered as healthy: it may also be regarded in the same light, where it follows any local irritation in a healthy constitution and part. In other cases it is complicated with some morbid tendency, as in erysipelas, scrophula, lues venerea, &c. and hence arise numerous species of unhealthy inflammation. Again, it may be acute or chronic, in respect to its duration.

Healthy acute inflammation has been called phlegmon. Its symptoms are, preternatural redness, increased heat, and a circumscribed, throbbing, painful swelling of the inflamed part. The exciting cause is generally some external violence, of a mechanical or chemical nature. Sometimes it arises spontaneously; or, in other words, no perceptible cause can be assigned for it. The proximate cause is, an increased action of the vessels of the part.

During its existence in any important organ of the body, blood taken away from the system, has the inflammatory crust, or buff, on the upper surface of the clot, which is at the same time concave or cupped.

Treatment. 1. Removal of the cause, where that is practicable. 2. Bleeding, both topical and general. The latter is only necessary when the inflammation of the organ endangers life itself, as the brain, lungs, liver, &c.; or when the part has inferior powers of recovery, as a joint; or where suppuration would entirely destroy the organ, as in ophthalmy. The former is effected by means of leeches or cupping. 3. Purgatives, chiefly of the saline kind, as Glauber's and Epsom salts, &c. 4. Antimonial medicines, which relieve the skin, and diminish febrile action. 5. Reduced diet, including abstinence from fermented or spirituous liquors, and animal food. 6. Evaporation constantly kept up from the surface by folded cloths, wetted with cold washes. This is very powerful in reducing the heat and increased actions of the part. A solution of ceruss. acetat. ℥ss. in ℥iv. of vinegar and ℔ij. of distilled water is a very good application. Where, on account of concomitant extravasation of blood, as in bruises, it is desirable to excite the absorbents, washes supposed to have this effect, and therefore termed discutients, are employed: such as ℞. ammon. muriat. ℥ss. aceti et spir. vin. rectif. āā ℔j. 7. Warm applications, as poultices, or fomentations, occasionally relieve, when the cold washes are ineffectual.

Inflammation terminates in resolution, which is the gradual subsidence of all the symptoms; in suppuration, or the formation of matter; or in mortification.

Suppuration. The inflammatory symptoms, instead of yielding to the treatment, are aggravated; and afterwards suddenly subside, the patient being seized with shiverings. The swelling becomes softer, and white at its most elevated part; and if the collection be superficial, a fluctuation can be felt. At this time a fluid, called matter, or pus, is contained in a cavity formed in the centre of the inflamed part, and termed an abscess. This peculiar fluid is separated from the blood by the inexplicable power of the secerning arteries, just as ordinary secretion takes place. In a healthy state it is a homogenous, light, yellow fluid, about the consistence of cream, and possessing little smell: but under many circumstances of disease, its appearance and properties are entirely changed. The cyst, containing the pus, has a smooth and somewhat villous surface: it seems to be lined with a layer of coagulating lymph, and the surrounding cellular substance is thickened and agglutinated by the inflammation, so as to prevent the matter from spreading. From the arteries of this part the pus is secreted.

The matter always makes its way towards the external surface of the body, even if the parts should be very much

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thinner and less resisting towards any cavity.

Treatment. A soft poultice, until the abscess bursts, or has been opened. The latter operation is performed by a straight two-edged scalpel, or an abscess lancet. It is not necessary, unless the collection be under a fascia, which may prevent it from coming forwards; or near a joint, or large cavity of the body, as the belly or chest. A poultice should still be applied after the bursting of the abscess.

Mortification ensues when the violence of the inflammation, or its duration, has completely exhausted the powers of the part. The pain subsides; the part becomes livid, or otherwise discoloured; the cuticle is elevated into a vesication by a turbid fluid; the pain and tension are diminished, and air is disengaged into the cellular substance, so as to cause a crackling sensation. To this stage the term gangrene is applied; but when the part has become quite black, and has lost its motion, sensation, and heat, it is called sphacelus.

The blood coagulates in the large vessels leading to the part, and consequently the separation of the limb is not followed by hemorrhage.

But mortification often occurs without preceding inflammation in parts and subjects where there is great weakness. Tying the artery of a limb; impeding the return of the venous blood; continued topical pressure in a weak constitution; cold, when followed by the opposite extreme; are causes of this description. A peculiar mortification, beginning at the toes of old persons, and proceeding upwards, is of this kind.

When the mortification has stopped, a defined boundary separates the dead and living parts; the lymphatics remove the connecting matter, so as to form a groove, in which suppuration commences; and this groove extends deeper and deeper, until complete separation is effected. Our treatment must be directed to the object of stopping the disorder; in which view attention to the constitutional disturbance, that is usually very great, is of primary importance. The state of the digestive organs will demand particular attention. The great pain frequently requires opium. Cold washes while the inflammation continues high; and afterwards a poultice of bread or linseed, alone, or in combination with very finely powdered charcoal, are the best topical means. Amputation of a limb can never be allowed, until the line of separation between the dead and living parts is clearly formed. When the inflammation is abated, and the separation is going on, (which should in general be left entirely to nature,) the constitution should be strengthened by every means both of food and diet. Hence bark, with wine and aromatic confection; fermented liquors, and a nourishing diet, become proper. Bark, however, is by no means so universally beneficial in mortification as many surgeons suppose: if sympathetic inflammatory fever be present, or derangement of the chylopoietic organs, it would certainly be hurtful; but, where debility shews itself, this remedy must be instantly employed. Opium is often very serviceable; and it has been represented by Mr. Pott as almost a specific in the mortification of the toes and feet of old persons, where it must be used in a very free way. The same remedy will be of service in other cases, where the disorder is preceded and accompanied with great pain, but not inflammation.

Erysipelas is a species of superficial inflammation, in which the red colour is tinged more or less with yellow, particularly towards the termination; it spreads rapidly and widely; there is swelling, without much elevation, hardness, or circumscription. The skin is glossy, and its colour disappears on pressure. The pain is of a burning or itching kind. It often changes its seat; and is attended, when it recovers, with desquamation of the cuticle. Sometimes vesicles are formed. It seldom suppurates; but when it does, the abscesses are very extensive, as adhesions seldom take place, to limit the expansion of the matter. Mortification ensues in some instances.

The constitutional affection varies considerably, according to the degree of local disturbance. Langour, head-ache, loss of appetite, nausea, vomiting, oppression of the stomach, and foul taste in the mouth, precede. It is most dangerous in the face, and attended with the greatest disturbance, often amounting to delirium.

Disorders of the chylopoietic viscera, and suppressed perspiration, are the most prominent causes of the complaint. Mild purgatives, diaphoretics, and the antiphlogistic regimen, are sufficient in the slighter cases. In more severe attacks, calomel, combined with other purges, and antimonials, is proper. Emetics, where the stomach is much distressed. Bark may be required after the disorder

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subsides. Cold washes, or poultices, to the part, as they seem to agree: the former are preferable, on the principle of checking the inflammation.

Carbuncle is a very violent unhealthy kind of inflammation, attended with a painful deep discoloration of the skin, a very remarkable thickening and induration of that part, and gangrenous suppuration under it, occurring usually at the back part of the trunk, and often constituting a symptom of the plague and other malignant fevers. Its size varies considerably. Openings form in the swelling, and give issue to a very offensive discharge; and in the end extensive mortification ensues. The fever, which is at first inflammatory, soon becomes typhoid; and strong marks of chylopoietic derangement are generally attendant.

The swelling must be completely laid open by a free incision through the brawny skin, so as to discharge all the matter and sloughs. Purgatives and emetics are proper for the disturbed digestive organs; and the debility which remains after the disorder has subsided demands strengthening medicines and food. Opium, when the pain is excessive.

Boils are similar to carbuncles, except that they are smaller, and require the same treatment; the state of the chylopoietic organs must be particularly regarded.

Œdema is an unusual accumulation of water in the cellular substance, occasioning a general swelling of the part, without discoloration, that pits on pressure, is uneasy rather than painful, and increases in a depending position. It arises from constitutional or local weakness. In the latter case, which alone belongs to surgery, let the cause be removed; put the limb in a horizontal posture; employ frictions with flannel, and camphorated, or other slightly stimulating applications, and then apply a moderately tight roller.

Burns are attended with violent inflammation of the part, severe pain, and fever. The cuticle is raised into clear yellow blisters. The part may be destroyed at once, and converted into a dead black substance, or it may slough from the subsequent inflammation. If vesications do not form, suppuration will probably not take place. Where the injury is very extensive, the breathing is much affected.

As burns are violent local inflammations, the antiphlogistic treatment, both locally and generally, was the usual surgical practice, until Dr. Kentish, who then practised surgery at Newcastle, introduced the opposite, but, as subsequent experience has proved, much more successful plan of applying hot oil of turpentine, or alcohol, and then covering the part with a liniment composed of ung. resin. flav. and ol. tereb. on the principle of maintaining the action of the part by an adequate stimulus, which is to be gradually diminished. The first dressing remains for twenty-four hours; and in the second, warm proof-spirit, or laudanum, may be used before the plaster is applied; which alone suffices for the third. When suppuration commences, powdered chalk, and a plaster of cerat. lap. calam. Opium and good diet are to be allowed at the commencement of the treatment, with the topical stimulus.

Effects of cold. When a limb has been frozen, heat must be communicated to it very gradually. The sudden application of considerable warmth will inevitably cause mortification. Rub the part with snow, as persons in northern countries do their ears or noses when thus affected, or with cold water, until motion and sensibility return. Then camphorated spirit of wine may be used, and, ultimately, a moderate approach to the fire may be allowed; or else the patient may be put in a warm bed, and warm flannels may be applied locally; general perspiration being at the same time promoted. The same principles must be kept in view when the whole body is affected. Volatiles and sternutatories may be used when animation has returned; and warm wine or spirits should be introduced into the stomach as speedily as possible.

Chilblains are caused by exposure of parts to the vicissitudes of heat and cold, particularly in young persons, females, and such as are brought up tenderly. Before they are ulcerated, ice, cold water or snow may be applied two or three times a day; and the parts should be kept dry, and in an uniform temperature. In some cases, topical stimulants seem more beneficial, as spir. vin. camph. or tinct. myrrhæ rubbed in; also vinegar and alum lotion. Sp. vin. camph. and tinct. cantharid. in equal parts, have been very useful.

WOUNDS.

These vary so much, according to their extent, the degree of violence employed, the powers of the part, its importance to

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life, complication with bleeding, fracture of bones, &c. that they must be considered under various heads.

The size of the wound is a matter of consequence, as a very large cut may produce serious consequences, although no important parts are injured. The degree of violence done to the fibres is another material consideration: a wound, in which the parts have been bruised, stretched and lacerated, as well as divided, will often mortify from that cause only; hence contused and gun-shot wounds are particularly dangerous. Such injuries too as expose circumscribed cavities are alarming, on account of the inflammation which generally follows such exposure; hence the danger of even a slight wound in the belly, chest, or large joints. A slight wound of a part, whose functions are intimately connected with life, is often fatal.

Simple incised wounds require only that the sides should be brought into a state of apposition, and maintained in than condition, by means of adhesive plaster, assisted perhaps by bandage.

Hemorrhage, which frequently attends these injuries, demands particular care, as it must be stopped before any thing else is done. If the blood flow from an artery, it is a florid red, and comes out in jets; if from a vein, the stream is uniform, and the colour dark purple. If the vessel be not large, the bleeding often stops of itself. The divided artery retracts; the surrounding cellular substance, becoming injected with blood, presses on its mouth; and, finally, the blood coagulates in the orifice. Thus the sides of the vessel grow together. But death would often take place before the bleeding stopped in this way, particularly if the vessel were large; or, at all events, great danger would arise from the bleeding. Hence it is always desirable to tie the mouth of the bleeding vessel, which secures us at once from all alarm on the subject of hemorrhage. A ligature, when properly applied, is found to cut through the two internal coats of an artery; the inflammation thus excited in the vessels of the part is attended with an effusion of coagulating lymph, which, together with the coagulation of the blood, effectually closes the tube, before the separation of the thread, which is seldom delayed beyond a fortnight. The ligature should include the artery only; or, when it is small, as little surrounding matter as possible; when the vessel is large, it may be drawn out with the forceps: in the latter case a tenaculum must be used. As much force may be employed in drawing the knot, as can conveniently be exerted by the hands.

The use of the ligature in hemorrhage is preferable to every other means: the tourniquet may be placed on the limb, until the vessel is found and secured.—When the main arterial trunk of a part is compressed by the pad of this instrument, there is no immediate danger of bleeding.

The tourniquet in common use, for which we are indebted to a French surgeon, Petit, consists of a band and buckle, a pad, and a sort of brass bridge, capable of being elevated and depressed by means of a screw. The band is first buckled round the limb in such a manner that the pad, which is attached to the band, is placed exactly over the artery. The bridge, over which the band proceeds, is to be then raised, by turning the screw, and thus a due degree of pressure is produced. It affords, however, only a temporary security. When a tourniquet cannot be procured, pressure may be made by any simple ligature round the limb, twisted to the requisite tightness by means of a stick.

Compresses and bandages will sometimes stop bleedings by their mechanical pressure; but are inferior to the ligature. If the bleeding vessel cannot be found, if there be rather a general oozing than an hemorrhage from any considerable vessel, or if the artery lie against a bone, as those of the scalp, this method may be employed.

When a large artery has received a small wound, as the brachial in bleeding, the following plan may be tried. Apply a tourniquet so as to command the flow of blood into the vessel, bring the edges of the external wound into contact. Bind on firmly with a roller a graduated compress, with the apex placed exactly in the situation of the wound of the artery. A longitudinal compress has sometimes been added in the course of the vessel, above the wound; but it would probably impede the circulation too much. Then let the limb be kept perfectly quiet.

The use of agaric, of the actual and potential cautery, and of styptics, as means of arresting hemorrhage, are banished from modern surgery.

When bleeding is stopped, and all foreign bodies, or coagula of blood, have been removed, the sides of the wound should be approximated by means

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of sticking-plaster, assisted, if necessary, by the position of the part, by bandage, &c. In forty-eight hours the sides of a wound, healed in this way, will be agglutinated, and the process by which they are united is named "union by the first intention." Sutures were formerly employed in the treatment of such wounds, but their use is restricted now to the very few cases where the sticking plaster cannot be conveniently applied, as the hare-lip, &c. They have fallen into disrepute as a general mode of treating wounds, principally because they tend to increase inflammation. The new wounds which they make, their irritation as extraneous bodies, the forcible manner in which they drag the living parts together, and their incapacity, in general, to accomplish any useful purpose, which position adhesive plaster and bandages cannot effect, are strong motives for reprobating their general employment. They often bring on such irritation as to render their removal necessary.

The sides of a wound, treated in the way now described, throw out coagulating lymph, which joins them together. This forms an uniting medium, through which new vessels shoot from the opposed surfaces. We cannot help admiring the celerity with which this uniting process is completed. The wound produced in amputating a thigh is often securely united in seventy-two hours; and the principles now detailed apply to the management of all wounds made by surgical operation.

Punctured wounds are often attended with more pain, inflammation, &c. than others. Enlarging their orifice is an unnecessary practice, unless abscesses, or extracting foreign bodies, should demand it. A soothing plan by means of emollient poultices, &c. is preferable.

Lacerated and contused wounds, on account of the violence attending their infliction, do not unite like simple cuts by the first intention. Yet they should be brought together, and inflammation obviated by the appropriate treatment.

If a wound does not unite by the first intention, it must granulate and cicatrize. Pus is secreted from its surface, which becomes red and uneven, rising into little protuberances, called granulations. These fill up the cavity of the wound to a level with the skin, which then grows over and covers them by a newly formed smooth pellicle, termed a cicatrix.—When this process is completed, the newly formed part is absorbed to a great degree, and hence the surrounding healthy skin is drawn from all sides over the situation of the wound, presenting a puckered appearance.

Gunshot wounds are attended with great laceration and violence, insomuch that the parts in their track are killed, and must be thrown off in the form of sloughs. They are very often complicated with fractures, wounds of arteries, viscera, and with the introduction of foreign bodies, as balls, portions of clothing, &c.

Immediate amputation is often necessary in gunshot wounds of the limbs; and often there is much doubt whether this means should be adopted or no. It may be done immediately after the accident, before suppuration, fever, &c. have supervened; or when the violent inflammation, swelling, &c. have abated. By deferring it to the latter period, the surgeon has often a chance of saving the limb; and if he does not suceeed, he operates under more favourable circumstances, as a patient habituated to disease bears an operation much better than a person in good health. Yet this is not meant as an argument against immediate amputation in any case; for by that practice a simple incised wound is substituted for a complicated lacerated one; and the constitution escapes that hazard which repeated suppurations, painful incisions, &c. are inevitably attended with. Besides, after the constitution is nearly ruined by the processes of recovery, from a dreadful injury, the limb is often no better than a wooden one.

Incisions at the entrance and exit of the ball are not necessary, unless there is an object to be accomplished. Foreign bodies should be extracted, if it can be done easily; but tedious examinations and incisions are improper, particularly when the belly or chest is wounded. The mildest dressing and treatments should be employed. Fomentations and poultices, and dressings of white cerate, answer every end.

Poisoned wounds. The stings of bees, &c. the bites of gnats, and other insects, are treated by cold applications, and attention to the constitution, if the general irritation be great. In the bite of the viper, alarming symptoms usually arise, *viz.* swelling, heat, and pain of the limb; small and weak pulse; head-ach and vomiting, &c. Perhaps excision might be proper at the very first; or, at all events, the wound should be carefully cleansed. Emetics, and volatile alkali, have been commended as constitutional means.

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Hydrophobia arises from the bite of a mad-dog, or other rabid animal. The wound heals, but in about three weeks a dull pain is again felt in it. Dejection of spirits appears at the same time, followed soon by the dread of water, and intolerable sense of suffocation and convulsions at any attempt to swallow fluids. Horror of the countenance, redness of the eyes, convulsive and violent movements, &c. continue to the time of death. Excision of the bitten part is the only preventive: it should be employed at any time previous to the accession of symptoms; the use of caustic, &c. is very uncertain. No remedy is of the least use when the symptoms have appeared.

Contusions, when slight, may be treated by cold applications, and quietude of the injured part. In other cases, topical bleeding, followed by discutient lotions, as sal ammoniac in vinegar and water, or fomentations of hot vinegar, and afterwards camphorated liniment, are required. Purging and venesection are sometimes necessary.

Polypi are fleshy excrescences, growing from a thin pedicle, and occurring most commonly in the nose and uterus.

Those of the nose are divided into the fleshy, or benign, which are white, soft, and unattended with pain; and the malignant, which are hard and painful, and, according to some, of a carcinomatous nature. They grow most frequently from the spongy bones; occasion at first an obstruction of the nose, and gradually fill up the whole cavity; extend backwards to the throat; expand the nostril by elevating the os nasi; destroy the other bones; and produce, successively, fistula lachrymalis, inflammation and ulceration of the schneiderian membrane, caries of the bones, &c.: some often bleed. They must be extracted by means of forceps; by which the tumour is seized, and torn away from its root. This process must be repeated until the nostril is cleared. If any present in the throat, they may be removed in the same way from that part. If troublesome bleeding should follow, and not yield to a probe armed with lint, moistened in a strong solution of white vitriol, and applied to the part, a piece of lint may be drawn into the posterior opening of the nose, by means of a ligature introduced through the nostril, and drawn out at the mouth; the front aperture being also stopped.

Polypi of the uterus occasion at first an enlargement of that organ, and various other symptoms, as pain, hemorrhages, &c. The tumour escapes from the uterus, and by its presence in the vagina irritates the rectum and bladder; causing still worse uterine affections, as bleedings, discharges of other kinds, &c. At last it descends through the external parts, with an aggravation of all the distressing symptoms. Now it must be carefully distinguished from the prolapsus, or inversic uteri. It should be removed by means of a ligature conveyed to its root in the uterus, by instruments designed for that purpose, as the double canula of Levret, or the improved instrument of Richter, represented in Cooper's "First Lines."

Ulcers are consequences of wounds that have not united by the first intention: or of a diseased process, named ulceration, in which a breach is made in the substance of the body by the absorbents A healthy ulcer has small florid and pointed granulations, which secrete a thick white pus. Here any simple dressing, confined by means of a roller, is sufficient.

But the ulcer may be irritable, *i. e.* attended with pain, a thin and discoloured secretion from its surface, ragged edge, no distinct granulations, &c. Here decoction of poppy-heads, used as a fomentation, emollient poultices, solution of opium, (ʒiss. to ℔j. of water) are proper; or it may be indolent, *i. e.* not painful, having thick edges, flabby colour, and imperfect granulations. Irritable ulcers are brought into this state by too long poulticing. Stimulating applications to the sore are proper here; as red precipitate, solution of lunar caustic, &c. combined with a roller, applied uniformly and firmly over the whole limb. But the most successful treatment is that proposed by Mr. Baynton, of Bristol, of surrounding the limb, for a considerable extent, with straps of adhesive plaster, applying a roller, and keeping wet cloths on the part, if there be pain. This practice indeed often succeeds, where the ulcer is of the irritable cast; the pressure of the roller is useful, and the cold water relieves the pain. It is most particularly beneficial in ulcers of the legs, attended with varicous veins: and, in short, is a very great improvement in the surgical treatment of ulcerated legs, as it does not require the patient to be confined.

There are various ulcers, not included under this arrangement, having peculiarities in their appearance, discharges, &c. They are often connected with disordered chylopoietic organs.

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Encysted tumours consist of a cyst of various thickness, containing a matter of very different consistence and appearances; according to which the tumour is called meliceris, the contents resembling honey; atheroma, when of a pappy nature; or steatoma, when of a fatty kind. They must be extirpated, care being taken to remove the whole cyst in an entire state.

Sarcomatous tumours are fleshy masses organized throughout, produced by chronic inflammation, sometimes being newly formed; at others merely enlargements of originally existing parts, possessing a more or less defined cyst or capsule, which is formed by a condensation of the surrounding cellular substance. Their structure is very various, sometimes consisting entirely of fat, at others of a fleshy vascular mass, in which there may be cysts, or division into something like lobes, &c. In the rapidity of their growth, pain, &c. they differ very much; some also affect the lymphatics, which others do not. As they are produced by chronic inflammation, local bleeding and cold washes will generally arrest their growth, and often reduce their size. Topical stimuli may also be employed with the view of discussing them; but extirpation is the only plan to be relied on. The mode of operating will be explained in speaking of the amputation of the breast.

Carcinoma commences with a hard painful tumour, termed a scirrhus, which, ulcerating, forms cancer. As several other swellings are both hard and painful, discrimination becomes particularly necessary. Scirrhus has an uneven feel, is attended with occasional darting pains, affects all the surrounding parts, so that the tumour becomes fixed to the muscles and skin, which latter has a dull leaden colour. When cut into, it exhibits a hard gristly appearance, with white ligamentous bands, extending into the surrounding fat. When it becomes a cancer, a large chasm is formed by ulceration and sloughing: the sore is unequal, with thick indurated edges, and copious discharge of fetid sanies, combined frequently with bleeding. A fungus often arises. Previously to this period the absorbent glands are generally swelled, and they afterwards take on the same disease. Extirpation in the earliest state is the only safe treatment: it may be performed after the glands are affected; but then those also should be removed. Here, however, as well as when ulceration has occured, the disease often recurs. Cicuta, belladonna, digitalis, mercury, arsenic, &c. have been tried internally without success. Opium is necessary as a palliative. Caustics composed of arsenics have often been used, in order to destroy the tumour by sloughing, probably never with success in a true scirrhus.

Ganglions are small hard tumours, not painful, containing in a cyst a fluid like white of egg, connected with a tendon, and occurring most frequently on the hands. Pressure, stimulating applications by means of friction, or extirpation by the knife, may be employed.

Aneurisms are swellings formed by the dilatation or rupture of arteries; the former being named true, and the latter spurious; but this distinction is of little use in practice. The tumour pulsates, except when the artery above is compressed; it is not painful; it may be made to disappear by means of pressure in an early stage. When it has grown to a great size, the pulsation is often diminished, for at first the blood does not coagulate in the bag, which is the case afterwards to a great extent. The size of the tumour becomes very inconvenient, its pressure causing œdema, caries, &c. The skin at last grows thin and bursts, when the patient dies of bleeding. Aneurisms of this kind generally occur spontaneously, from a diseased state of the arterial coats; but sometimes a strain or blow gives rise to them.

When an artery is wounded, and the blood escapes into the cellular substance, a false aneurism is formed. This happens at the bend of the arm from bleeding. The swelling is irregular, the skin livid, and pulsation may or may not be present.

The *varicous aneurism* is where the artery has been wounded in phlebotomy, and the blood escapes from it into the vein, causing a varicous enlargement of that vessel, with pulsation, and a peculiar hissing noise. This is not dangerous, and requires no treatment.

The *treatment* of aneurism consists in preventing the flow of blood into the tumour, which then gradually diminishes. Hence it is obvious that those of the aorta can admit of no remedy. In the limbs, however, they may be cured by the operation of exposing the artery at a considerable distance from the tumour, nearer to the heart, passing a double ligature under it, tying these at the parts where the vessel is surrounded by its natural connections, and dividing it between them. A single ligature will be sufficient, but it is not so safe. In this way any artery may

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be operated on, from the axillary above the clavicle, the external iliac above the crural arch, and the carotid by the side of the trachea, down to their respective ramifications. The false aneurism should be opened opposite to the wounded part of the vessel, the tourniquet being previously applied, the coagula removed, and two ligatures placed on the artery, as in the preceding kind.

Varices are dilatations of the veins, occurring in parts where the return of the blood is contrary to gravity, or where pressure is made on the trunks so as to obstruct that return: hence they are most frequent in the legs. The affected vessels swell into irregular knots, in which the blood is at first fluid, but afterwards coagulated. The complaint at first is not painful, but afterwards becomes so, and gives rise to troublesome ulcerations. The vessel sometimes bursts, and considerable bleedings follow.

The cause should be removed, and a tight bandage applied, the horizontal position being preserved. When this treatment does not succeed, the trunk of the vein may be tied with two ligatures, and divided between.

Hemorrhoids, or *piles*, are varices often attended with hemorrhage. Leeches, cold applications, attention to regimen, open state of bowels, and balsam copaivæ, are means of temporary palliation. A radical cure may be effected by cutting off the excrescences with scissors, or tying them.

Scrophula attacks particularly the lymphatic glands and bones, occasioning a soft indolent swelling in the former, and a softening, together with a carious affection, of the latter. After remaining enlarged for a long time, the skin, covering a scrofulous tumour, becomes of a light purple, and bursts, discharging an unhealthy matter, and leaving an ill-conditioned sore. Such attacks take place in several parts. They generally occur in peculiar constitutions, and the affection is considered hereditary. In the treatment we endeavour to give strength to the constitution; bark, sea-air, and sea-bathing, are particularly serviceable. Attention to the digestive organs is particularly necessary. Alkalies have generally been relied on, but without due grounds; acids deserve a preference. The local treatment is not of much importance. The suppurations should not be opened. The scrofulous affections of the bones will be considered under *Joints*.

Cow-pox (variolæ vaccinæ, vaccina, &c.) This is an universal poison, derived from certain specific sores on the teats and udders of cows, and capable of being communicated by accidental contact, where the cuticle has been removed, or by means of inoculation, to the human subject. A person who has been thus affected is rendered for ever after incapable of receiving the small-pox infection. That subjects, who have taken the vaccine disease accidentally, were thereby secured from the small-pox, was popularly known in several of the dairy counties of England. But it was reserved for Jenner to show that the cow-pox could be propagated by inoculation, and that the inoculated disease possessed the same prophylactic power as the original disorder. It is not a merely local affection, but produces a general, though extremely mild, disturbance of the constitution, which is ordinarily so trivial as not to excite any alarm in the very youngest subjects. It seems probable, at present, that it is not an infallible security against the small-pox, although the number of failures is very small, when due allowance has been made for the mistakes of the ignorant, and the misrepresentations of the designing. A small inflamed spot, distinguishable about the third day, shows that the inoculation has succeeded. This increases in size, becomes hard, and raises above the level of the skin. A small quantity of fluid can be discerned in the centre on the sixth day, and the pustule increases until the tenth day. This fluid will communicate the disease by inocculation. On the eighth day, when the pustule is fully formed, the constitutional effects begin to appear, and manifest themselves by slight pain in the part and axilla, head-ach, shivering, loss of appetite, &c. These subside spontaneously in one or two days. During the general indisposition, the pustule becomes surrounded with a broad circular inflamed margin, called the areola. Afterwards the fluid dries up, and a dark brown scab forms, which remains for about a fortnight.

Venereal disease. This arises from the application of a peculiar morbid poison to the body, which affects various parts in succession. It first attacks the genitals of either sex, where it appears in the form of a circular ulcer or ulcers, with a white dirty concave surface, and thickened edge and basis, called chancres. These characters distinguish them from various other ulcerations and excoriations, to which the same parts are exposed. The matter absorbed from these, causes swellings of the

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lmyphatic glands, named buboes. After a certain length of time, an ulcerated sore throat appears, attended with a peculiar copper-coloured eruption on the skin. The ulcer of the throat is excavated, and the chasm appears foul on the surface, with an appearance like a white slough, and a defined edge. The eruptions vary considerably; they have generally a reddish colour; the cuticle peels off and forms again successively; at last a true scab appears, under which ulceration takes place. After some time swellings of the bones, called nodes, appear, and gradually suppurate. These are very painful, particularly at night. The affections of the throat, skin, and bones, form what are called the constitutional symptoms of the disease, or lues venerea.

The treatment of this disorder, in all its stages, consists in the exhibition of mercury, until it produces its peculiar effects on the constitution: these are, universal irritability, quick pulse, &c. together with increased secretion of saliva, soreness of the gums and mouth, &c. This action, excited by mercury, destroys the action of the disease in all its forms, and may be considered as a specific and certain cure of the disorder. The remedy is most frequently introduced by friction on the thighs; half a drachm being first employed for half an hour every night, and increased to two or three drachms. The pil. hydrarg. is the most common preparation for internal use; it may be taken at first in doses of five grains, morning and night. Hydrarg. calcin. gr. j. with opium, and corrosive sublimate, are less frequent modes of exhibiting mercury. Lastly, mercurial fumigations have been employed, by exposing the patient, naked, in a wooden box, to the fumes of the pulvis dydrarg. cinereus, thrown on a heated iron. The effect of mercury on the salivary secretion and gums is considered as the criterion of its action on the system at large; this should not be allowed to become considerable, as the effects on the constitution are very pernicious. A very slight affection of the gums, continued from six to twelve weeks, will be adequate to the cure of most venereal complaints. The action of the remedy is usually maintained for a fortnight after the symptoms have disappeared, for the sake of security. Violent and long continued salivation often aggravates the complaint, and becomes the source of other disorders. Decoction of sarsaparilla, mezereon, guaiacum, &c. nitrous acid, opium, and other remedies, have been employed in venereal cases; but the most that can be said of them is, that they are useful restoratives after the long employment of mercury. This is particularly the case with the nitrous acid.

There is not much to be said on the local treatment of the different venereal symptoms. Chancres, when very small, have been destroyed by lunar caustic, or excision: they may be dressed with mercurial ointment, or any solution of metallic salts; or with solution of opium if irritable. Buboes may be poulticed, if painful.

AFFECTIONS OF JOINTS.

White swelling attacks the larger articulations most frequently. It consists in an indolent tumour of the part, without affection of the skin, impairing the motions of the joint; arising from a diseased state of the bones and ligaments, which causes a general thickening of the superincumbent parts. The enlargement proceeds, the joint becomes painful, and abscesses form; the patient at last dying hetic. The treatment consists in subduing completely all increased action in the part by leeches, cupping, cold washes, &c. continued while there is any remains of pain or heat; and afterwards in keeping up a drain from the skin by means of caustic issues; or, what seems to be more advantageous, by Mr. Crowther's plan of blistering, and dressing the surface with unguentum sabinæ. These drains should be continued for six, twelve, or eighteen months. Perfect rest is indispensable. The constitution of the patient, which is frequently of the scrofulous kind, demands the greatest care: bark, sea air, &c. are therefore particularly proper in such cases. Where the joint is too thoroughly diseased, and the constitution is sinking, amputation must be performed.

Loose cartilaginous substances are most frequent in the knee, where they excite inflammation, and are very troublesome when they get between the ends of the bones. They must be removed by means of an incision over the inner surface of the internal condyle, where they can be easily fixed by an assistant; the wound should be closed instantly, and every attention paid to keep off inflammation.

Hydrops articuli occurs after inflammation or injury, and may be dispersed by blisters and savine ointment; or by friction with camphorated liniments or mercurial ointment, united with mercurial purges.

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DISEASES OF BONES.

Necrosis is the death of the whole of a bony cylinder, excepting its articular portions; and is most frequent in the thigh and tibia. The periosteum separates from the affected bones, becomes thickened and vascular, and forms a new case surrounding the old bone, and at last absorbing it. This process occupies many years, is attended with great pain and swelling of the limb at first, and subsequently with abscesses, which lead down to the old bone, and afford issue to copious fetid suppurations. In some instances the old bone, which is called the sequestra, has been removed by a surgical operation, particularly in the tibia. Where this cannot be admitted, blisters dressed with savine, or issues, will remedy the irritation and prevent suppuration, while the absorption of the old bone is going on. Leeches, cupping, &c. may be required, if inflammatory symptoms manifest themselves. Sometimes amputation is necessary, particularly in poor persons, whose circumstances will not admit of delay.

Exfoliation is the term applied to the death of a small portion of bone, in which generally the surgeon must wait until nature has separated the dead part.

Caries is a disease of the substance of a bone causing foul, ill-conditioned ulcers, and attended with occasional exfoliations. Means which reduce inflammation are proper at first, followed by counter irritation.

Rickets is a disorder consisting in a flexibility of the bones, and consequently, a deformity of the part affected, occurring generally in weak children. The constitution should be strengthened, and mechanical means will often in an early stage have considerable effect in restoring the deformed part.

Fractures are either simple or compound. The former are usually attended with a distortion of the limb; with a grating or crepitus, perceptible on rubbing the broken ends against each other; with pain and swelling; and often with spasms of the muscles. The accident is remedied by the effusion of a soft vascular matter between the broken ends; and by the gradual deposition of earth in this; where it acquires a sufficient firmness to admit of the part being used again at various periods, from three to seven weeks. The new matter is called callus. The treatment must, consequently, consist simply in bringing the limb into its natural position, and retaining it there firmly, until the union is accomplished. In effecting the former object, some force is often necessary, where the muscles have shortened the limb, as is frequent in the thigh; and this is termed extension. The latter end is attained by means of instruments called splints, which are firmly bound on the broken limb, including generally the joints which connect it to the neighbouring parts, and which of course must vary in their form, &c. according to that of the part on which they are placed.

Compound fractures are those in which there is an external wound, made by the broken bone, which generally protrudes through it. Here the violence suffered by the limb is much greater; inflammation of the surrounding parts, extensive abscesses, exfoliations of the broken ends, and great constitutional sympathy, may be naturally expected. Where the injury is very violent, the bone much shattered, and the soft parts lacerated considerably, immediate amputation may be performed. Otherwise close the external wound; lay the limb in its natural position, and keep it so; and pay strict attention to the constitution. Extensive abscesses, &c. may render amputation necessary at a subsequent time.

Dislocations, or luxations, are the displacements of the articular surfaces of bones, by external violence. Hence their symptoms arise from the altered form and impaired functions of the parts. The head of a bone is out of its natural socket, and is lodged in some unnatural situation; the limb cannot be moved by the patient; there is great pain, aggravated by the surgeon's examination. The bone must be restored, by means of force, to its proper place, and the limb kept quiet, until the effects of the violence are gone off. Compound dislocations must be treated on the same principles as compound fractures. Sawing off the end of the bone is quite unjustifiable in any case. If a luxation be unreduced for a few weeks, the bone in general cannot be replaced, and the patient becomes crippled. Dislocations are sometimes produced by diseases of the joints destroying the ligaments.

PARTICULAR SURGICAL SUBJECTS.

The great number of these, and the limits prescribed by the nature of this work, render it necessary for us to pass over several, and attend only to the more important.

Injuries of the head. Fractures of the

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skull are not dangerous in themselves, but they indicate that considerable violence has been inflicted. We must guard against inflammation of the contents of the cranium, and continue the antiphlogistic regimen for three or four weeks. If the bone be even slightly depressed, the same plan may be pursued. Bleeding from the arm or temporal artery, saline purges, and diaphoretics, are usual means.

Compression of the brain may be caused by fracture with depression, or from extravasation of blood under the skull. Its symptoms are, insensibility, dilated and immovable pupil, slow and labouring pulse, difficult and stertorous respiration. These demand the application of the trephine, for the purpose of elevating depressed bone, or removing effused blood. Compression may also be caused by suppuration of the dura mater. This happens several days after the accident, is indicated by peculiar symptoms, as pain, feel of tightness, and puffy tumour of the integuments; and demands the use of the trephine.

Concussion of the brain is an injury of that organ produced by the blow, independent of actual fracture of the skull. After the first stunning subsides, there is sickness, contracted pupil, a degree of sensibility and irritability, and free respiration. The patient gradually goes into a state of phrenitis. Copious and repeated bleedings from the temporal artery and arm, saline purges, low diet, &c. are the only means of safety, and must be followed up until the symptoms are subdued.

Trepanning consists in removing, by means of a circular saw, a portion of the skull, in order to allow the elevation of depressed bone, or the evacuation of blood or matter. The scalp must be divided by an incision down to the bone, and the sides of the cut turned up; these are laid down again, and approximated, after the operation. Trepanning is not to be performed merely because there is a fracture or depression; but only when symptoms exist, showing that the brain is suffering from pressure.

Tinea capitis, or scald-head, is a superficial ulceration of the scalp, covered by thick dry scabs. Cleanliness is the most essential part of the treatment. The scabs must be removed, the head kept closely shaved, and the ulcers dressed with the ung. picis cum sulphure, or ung. hydr. nitr. or lotion of kali sulphuratum. Alterative medicines must be given at the same time.

Hare-lip is a deformitity existing from birth, attended frequently with a fissure in the jaw and palate. Its cure consists in paring the margin of the fissure, and bringing the edges into contact, where they are held by means of pins, and the twisted suture; which is a thread passed over the pins in the form of the figure 8. They thus unite by the first intention. It should not be performed on very young children, as they are less manageable, and are liable to convulsions. The removal of the edge of the fissure is performed by means of forceps, by which the lip is held firmly, leaving out the part which is to be cut off, and which the surgeon removes at one stroke of the knife.

The same operation is necessary for cancerous ulcers of the lip, which commence in ulcerated, wart-like excrescences, and spread very destructively. They should be removed as soon as we can ascertain that they do not yield to our remedies.

Diseases of the antrum are, inflammation and suppuration of that cavity, and fungous growth from its surface. The former requires an opening by the extraction of one of the grinders, and the introduction of a pointed instrument through the socket. In the latter, the cavity should be trephined, and the fungus removed.

The *noli me tangere*, or spreading herpetic ulcer about the nose, is a very untractible complaint. Alterative medicines should be given internally, together with cicuta, and even arsenic: ung. hydr. nitr. ung. picis., solution of lunar caustic, and of arsenic, as topical applications.

Fistula lachrymalis arises from obstruction of the ductus nasalis, which causes a swelling in the corner of the eye, flux of the tears over the cheek, and afterwards a fistulous opening from the lachrymal bag. Its cure, in an early state, is by injecting warm water through the puncta, using a collyrium of white vitriol, and smearing the edges of the eye-lids with ung. hydr. nitr. In a more advanced state, an incision into the lachrymal bag is required, together with a forcible removal of the obstruction, and the introduction of a straight silver nail-headed style.

DISEASES OF THE EYELIDS AND EYES.

Psorophthalmy and *lippitude*, or inflammation of the edges of the eyelids, with

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itching, &c. ung. hydr. nitr. lowered, rubbed on at night with camel-hair pencils; vitriolic colyrium, and alterative medicines.

Purulent ophthalmy. Red, swollen, and everted state of the eyelids, with discharge of purulent matter, particularly in children. Inject under the eyelids solutions of camphor, or the metallic salts.

Ectropium, or eversion of the eyelids, followed by an indurated and callous state of the conjunctiva. Remove a portion of that membrane. Exactly the reverse of this is the *trichiasis*, or inversion; where the hairs rub against the eyeball, and where a portion of the skin of the eyelid must be removed. *Hordeolum*, or sty, requires an emollient poultice, and touching with argentum nitratum.

Ophthalmy, or inflammation of the eye, distinguished into the first, which is called the acute stage, attended with heat, pain, fever, &c. and the second, or chronic period, in which there is a weakness of the organ. Remedies of the first are; in slight cases, low diet and gentle purging, with keeping off the light; afterwards, in the chronic state, one of the following collyria. ℞ Zinc. vitriolat. gr. v. aqu. rosæ, ℥ iv. ℞ Ceruss. acet. gr. viii. Aq. feniculi ℥ vi. Spt. vin. camph. gtt. x. In more severe cases, general and local bleeding; blisters to the temples, behind the ears, and to the nape of the neck; warm emollient applications to the eye, total darkness, and the antiphlogistic regimen in every respect. Where the chronic state has commenced, astringent collyria, or the tinct. thebaica, dropped once or twice a day between the eyelids. When the complaint is very protracted, the state of the constitution in general, or of the digestive organs in particular, often is the cause; hence alterative remedies, attention to regularity of the bowels, pure air, exercise, &c. become necessary.

Opacity of the cornea, varying in extent or intensity, and hence divided into nebula, albugo, leucona, &c. often accompanied with varicous vessels in the conjunctiva. Collyria of corrosive sublimate; ung. hydr. nitr. to the opaque part, touching it with argent. nitr.; cutting the enlarged vessels of the conjunctiva. Ulcers of the cornea should be touched with argent. nitr.

Ptreigium is a reddish, loose, triangular membrane, growing over the cornea; and must be removed by an operation.

Staphyloma is a protrusion of the cornea between the eyelids, consequent on various affections of the eye, and always attended with entire destruction of the organ of vision. Cut away the projecting part, in order that the globe may collapse.

Prolapsus of the iris through a wound or ulcer of the cornea; if all the inflammation has subsided, touch the tumour repeatedly with argent. nitrat. until it is destroyed.

Hypopyum is the collection of a yellow purulent fluid behind the cornea, consequent on inflammation of the eye. If the ball should seem much distended, an opening may be made for its discharge; otherwise attend only to the complaint which causes it.

Dropsy of the globe terminates in protrusion of the organ through the eyelids, ophthalmy, and destruction of the part. The projecting cornea may be cut away, that the distended globe may collapse.

Cancer of the eye should be treated by extirpation of the organ, as soon as the disorder is recognised. The outer angle of the eyelids may be divided to give room; these parts should be preserved, unless included in the disease; and care must be taken not to penetrate the thin walls of the orbit in the operation.

Gutta serena, or *amaurosis*, is a paralytic affection of the optic nerve, inducing blindness: it may be either complete or incomplete; inveterate or recent; continued or periodical. The iris is immovable, and the pupil dilated; there is strabismus; insects, or loose substances, seem floating in the air before the complaint is formed. The incomplete recent form of the disease is most frequently curable; the complete inveterate amaurosis seldom admitting of cure. The former generally arises from disorders in the primæ viæ, and should be treated with emetics, and the following pills: ℞ gum sagapen. galban. sap. ven. ā ā ʒ i. Rhei ʒiss; antim. tart. gr. xvi; succ. liq. ʒ i. M. fiant pilulæ granor v. Three to be taken morning and evening for six weeks. Bark, pure air, &c. must be resorted to afterwards. Such cases as arise from organic injury, or disease of the part, or are attended with exostoses of the neighbouring bones, or with acute and continued pain in the head and eye-brow, &c. afford little hope of success. Electricity has sometimes succeeded.

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Cataract is an opaque state of the crystalline lens, inducing blindness. Its attack is gradual; a slowly-increasing mist surrounding all objects. The pupil becomes opaque, and these symptoms proceed to an almost entire loss of sight, and milky whiteness of the pupil. A power of distinguishing light from darkness, however, generally remains, and the iris still contracts on exposure to light, which two circumstances distinguish the case from amaurosis. It has been divided into the hard, soft, or caseous, and milky or fluid kinds, according to its consistence; but these cannot be recognised before the operation. The case is often complicated by the co-existence of other affections, as chronic ophthalmy, lippitudo, gutta serena, adhesion to the iris, &c. It comes on spontaneously, and the only mode of treatment is by a surgical operation; the lens may be taken out of the eye by a cut in the cornea, or it may be moved backwards and downwards in the vitreous humour, so as to be removed from the axis of vision; the former operation is called extraction, and the latter couching. A favourable case for the operation is where the eye retains its sensibility to light; where there is no headach nor ophthalmy; no adhesion to the iris. If amaurosis accompany the cataract, the operation would be of no use.

Couching is performed by means of a sharp-pointed, slender instrument, called the couching needle, introduced into the globe of the eye, about one-eighth of an inch behind the cornea, carried in front of the cataract, and then moved downwards and backwards, so as to displace the opaque lens from the axis of vision. The cataract will be absorbed in time, when it is thus removed from its natural connections. If the lens should be in a milky or caseous state, the pupil will not become clear at the time of the operation; but the opaque fluid, or any fragments, will be absorbed afterwards. If there be adhesion to the iris, beware of too much violence, and rather repeat the operation. Needles have been made of various shapes, those of Mr. Hey and Scarpa are the best.

Extraction is performed by cutting the lower half of the cornea, near its junction with the sclerotica, with a slender knife carried across the eye by one motion of the hand. A scratch is then made in the crystalline capsule, through which the cataract escapes. The dexterity required in performing extraction, and particularly in making the cut through the cornea, is only to be acquired by long practice; and this operation has consequently become confined almost entirely to the oculists.

Much has been written on the respective advantages of the two operations: the merit of ease of performance, simplicity and mildness in the subsequent symptoms, belong to couching; also that of the power of repeating the operation. Extraction is more difficult, attended with greater injury to the eye, and consequently greater inflammation, but it removes the cause entirely.

After both operations light must be carefully excluded, and every precaution taken against inflammation. The use of convex glasses is required as an assistance to the sight, rendered necessary by the loss of the lens.

The capsule of the lens sometimes becomes opaque after the operation, and thus a secondary membranous cataract is formed, requiring the operation.

DISEASES OF THE MOUTH.

Ranula is an indolent tumour, formed under the tongue, consisting of a membranous cyst, containing a fluid, generally like white of egg, and occasioning no inconvenience until its bulk becomes troublesome. If punctured, it will collect again. Cut away that surface of the bag which projects, and rub the remainder with lunar caustic. Tumours under the tongue may be entirely removed; and calcareous concretions in the ducts must also be cut out.

Shortness of the fremum of the tongue, causing a preternatural confinement of the organ, may be remedied by dividing it to the requisite extent with blunt scissors.

Ulcers of the tongue may arise from the rugged edge of a tooth, which should be made smooth; from the use of mercury, when pushed to salivation; from disorders of the primæ viæ, foul state of the stomach, &c. in which case emetics, and afterwards alterative medicines, are required. They may, lastly, be of a cancerous nature, commencing in a small substance of the scirrhous tumour, or an induration of the tongue, and accompanied with hard irregular edges, and foul discharge. This cancerous state of the organ will end inevitably in a miserable death, unless an operation for the removal of the disease be performed. This may be accomplished by the bistoury, or by a double ligature passed through the substance of the

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organ, and tied so as to include the disease. If the glands under the jaw have been affected, it is too late to operate.

The *tonsils*, when inflamed, sometimes swell so as to impede deglutition and respiration, particularly when abscesses form in the neighbourhood. They may be scarified freely by the pharyngotomus (which is a lancet contained in a sheath); and the same instrument may be employed in opening collections of matter. An indolent enlargement of the tonsil may be remedied, by cutting away the projecting portions by means of a hook and bistoury; or by means of ligature.

The *elongated uvula* requires astringent gargles, or the removal of its extremity by scissors constructed for the purpose.

AFFECTIONS OF THE NECK.

The wounds of this part, inflicted in attempts at suicide, often require the surgeon's assistance. After stopping any bleeding vessels, let the wound be approximated, by bringing the head forwards on the neck, and retaining it in that position. Sutures, placed in the trachea, cause great and very detrimental irritation: yet if the tube be cut completely through, and position alone will not bring the ends together, a suture should be placed, so as not to affect the lining of the tube. If the œsophagus be wounded, a hollow bougie should be introduced through the nose, for the purpose of conveying nourishment into the stomach; and this may even be necessary when the trachea alone is injured. Inflammation may require bleeding, and the antiphlogistic plan. If there be cough, almond emulsion, with opium, will afford service. Foreign bodies, lodging in the œsophagus, may be either thrust down into the stomach, or drawn upwards through the mouth. The former plan may be pursued with those which can produce no harm when in the alimentary canal; the latter, with such as might prove hurtful from their hardness, indissolubility, pointed angular shape, &c. Indeed, bodies of the latter description, if very low down, must still be pushed on into the stomach, as they hardly admit of extraction. When the substance is near the throat, a curved pair of forceps may remove it; there is also an instrument made of strong flexible wire, doubled and twisted together, and bent at the end into a noose like a hook; and other mechanical contrivances have been suggested. A common probary, probably, is the best instrument for pushing bodies onwards to the stomach, which must be done, whatever their nature is, when they cannot be got out, and produce troublesome symptoms. Often they are loosened, after a time, by suppuration, if small; or they may be discharged by abscesses; or, as pins and needles, may traverse parts of the body, and appear at a considerable distance.

Bronchotomy is an operation in which an opening is made into the trachea or larynx, for the purpose of inflating the lungs, in cases of suspended animation; for the continuance of respiration, when the natural passage is obstructed by disease; or for the extraction of foreign bodies from the trachea. In instances of apparent death, from drowning, &c. it is our first object to restore respiration; the suspension of that function has caused the stoppage of the other actions, and its restoration is essential to the putting of the animal machine again in motion. If this cannot be done by the means laid down in the article DROWNING, the simple operation which we shall describe may be performed. Again, in diseases or tumours about the throat or trachea, and in cases where suffocation is threatened by a foreign body in the latter tube, the same remedy is necessary. A longitudinal incision of two inches should be made in the middle of the neck, commencing just above the sternum, and continued upwards; the parts should then be separated with the finger and handle of the knife, so as to expose the trachea, which may be opened by a longitudinal cut of half an inch. Some have advised this operation to be performed by a transverse cut between the thyroid and cricoid cartilages; and others by a longitudinal incision in the projecting part of the thyroid, called pomum Adami.

Wry Neck, is a deformity in which the head is drawn towards one of the shoulders; arising either from undue contraction of the sterno-cleido mastoideus, (whose fibres will be found in a very tense state) or from a relaxation, or paralytic condition of the opposite muscle. Perhaps cicatrices from wounds may sometimes be a cause. If it occurs in early life, and continues long, the vertebræ of the neck, and even of the back, may become deformed.

Treatment; camphorated mercurial frictions, and other stimulating applications, electricity, blisters, issues, mechanical means being at the same time employed: this plan is more particularly proper when there is induration. Divi-

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sion of the clavicular portion of the muscle, by a surgical operation, is most to be depended on.

Bronchocele, is an indolent enlargement of the thyroid gland, the causes of which are unknown, but which often attains an immense magnitude, and is endemic in several mountainous countries, as Switzerland, Savoy, Derbyshire, &c. Burnt sponge, in the dose of a scruple, two or three times a day, formed with syrup into troches, which should be placed under the tongue, and allowed to dissolve gradually, is the most certain remedy for this disease. Previously to commencing this plan, a grain or two of calomel should be given at bed-time for three nights, and a dose of the magnesia vitriolata on the following morning. This should be repeated again in three weeks, the sponge being then omitted, and the same alternation should be observed during the cure. Topical means may be combined; as friction with a dry towel, or camphorated liniments, &c.

Wounds of the Thorax. Much probing should not be employed to ascertain whether the cavity is penetrated or no, as symptoms will best indicate this point. Passage of air from the cavity, or protrusion of the lung, are appearances which show immediately that the cavity is exposed.

Emphysema, is an inflation of the cellular substance, commencing at the chest, and extending over the whole body, arising from a wound of the air-cells of the lungs, and generally produced from broken ribs, or narrow punctured wounds: for in either of these cases, the air, which issues from the wounded lung in inspiration, has no external discharge, as in instances of large and open wounds. It is surprising to what extent this inflation may proceed: and as the lung at the same time collapses, the greatest distress is experienced in breathing; yet the swelling of the body is not the dangerous part of the case. Our object is to give a free exit to the air, which may be done by a cut near the injured part, and even, if symptoms require it, into the chest. The air may be discharged from other parts by incisions through the skin, and pressing towards the wound. In about three or four days, the wound in the lung heals, and the air in the chest and cellular substance is absorbed. Bleeding, and other parts of the antiphlogistic regimen, must be used without restraint. Bandages on the chest generally increase the distress.

Wounds of the lungs are indicated by the coughing of blood, by the discharge of that fluid, with air, from the wound, impaired respiration, &c. Though they are often very speedily mortal, yet patients have in many instances recovered. The freest use of the lancet is required, with every other part of the antiphlogistic treatment; perfect rest; light dressing of the wound, which must not be probed. Paracentesis thoracis is required, where it appears that water, air, blood, or pus, are accumulated in the cavity, and give rise to danger by their presence. When there are symptoms indicative of these circumstances, the operation is easy; and it may be done, unless the circumstances point out any other spot, between the sixth and seventh true ribs, about midway between the sternum and spine. The integuments should be drawn aside before the first incision, that the opening may be valvular. After cutting about two inches through the skin, dissect down cautiously to the pleura, keeping close on the upper edge of the rib; when a small puncture is made in the pleura, it may be enlarged to the requisite extent with the director and curved knife.

Removal of a diseased breast. In this operation, and in the extirpation of tumours in other parts, the surgeon must attend carefully to remove all the disease; hence the integuments should be included, when they deviate at all from the healthy condition; and the pectoral muscle should also be taken away, if the tumour adheres to it, as far as it may have become indurated. In all cancerous complaints, it is most advisable to extend the incision even beyond the seat of actual disease: as a morbid disposition may have been formed, and would lead to the reproduction of the disorder. Where the skin does not participate in the disease, its removal is unnecessary; the first incision, therefore, may be a simple cut in such a case; while in others two semicircular cuts should be made, meeting at their extremities in acute angles. The tumour should then be separated all round from the surrounding parts; and lastly, the base is to be detached from its connections from above downwards. The cut surface should then be carefully examined, to see if any indurated parts have been divided, for in that case some portions have been left behind, and ought to be taken away. Arteries may be tied as they are divided, if they bleed profusely. When enlarged glands in the axilla re-

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quire removal, the incision must be extended in that quarter, and the indurated parts completely removed, caution being necessary, on account of the proximity of the large vessels and nerves. When the hemorrhage is stopped, the sides of the wound must be brought together by sticking plaster.

Wounds of the abdomen. These may, or may not, injure the contents of the cavity; but the mere circumstance of their penetrating it constitutes a source of great danger, from the peritoneal inflammation which is likely to ensue. We may not be able to discover whether the cavity is exposed or no; but this is of no consequence. A small, feeble, and contracted pulse; pallid countenance; coldness of the extremities; great and sudden debility; hiccough; vomiting; and tension of the abdomen; show that some important parts are injured. A bloody state of the urine; discharge of blood by vomiting and stool; escape of urine, feces, or chyle, by the wound; indicate to us what particular parts are included in the injury. A protrusion of the viscera is a frequent attendant on these cases. The subsequent occurrence of the symptoms described as belonging to peritonitis (see MEDICINE) is the natural consequence of the injury, and brings the greatest danger to the patient.

The *treatment* divides itself into two parts as regarding the wound, and the constitution in general. An over anxiety to discover the extent of the wound, and the parts injured, is useless and reprehensible; if these facts cannot be made out with facility, the surgeon must be contented to remain ignorant of them. Protruded parts must be immediately restored in the most gentle way, and the wound may probably require dilatation for this purpose; which the surgeon may accomplish with the probe-pointed curved knife, guided by his finger or a director. Fomentation of such parts is perfectly useless. A discoloured state of intestine is no reason why it should not be replaced; if it looks very suspicious, it may be retained near the wound by a suture through the mesentery. If the gut be wounded, three simple stitches may be made at three different parts of the circumference, and the part retained near the wound. To attempt to unite the edges by making them touch at every point, would be obviously nugatory. The ensuing inflammation agglutinates the gut to the surrounding parts, and thus the breach becomes gradually closed, while the extravasated matter readily escapes through the wound, behind which the injured part is confined. If the wounded portion of the gut be within the cavity, we must trust to the powers of nature, observing only to facilitate the discharge of the intestinal contents. Sometimes in such a case a perfect cure is obtained; sometimes the feces are discharged for ever after through the wound, and sometimes a fistulous opening remains. Should the return of a large piece of omentum be very difficult, it may be cut off, and any bleeding vessels secured. The wound should then be accurately and firmly closed by means of sticking plaster, aided by an attention to position, which is much better than using sutures. The introduction of tents is a part of the old practice, contrary to all principle, and therefore universally exploded. The general treatment of the patient requires a strict observance of the antiphlogistic plan; perfect quiet, abstinence from animal food and fermented liquors, and mild purgatives, should be employed in every case; and where symptoms of inflammation exist, even although the pulse should be small, copious bleeding from a large orifice is absolutely necessary. Cupping, or leeches to the abdomen, followed by fomentations and blisters, will also be necessary.

Gunshot wounds of the abdomen are very seldom attended with protrusion of the intestines. The treatment is here limited to the employment of general means, which have sometimes the happiest effect under very unpromising circumstances.

Wounds of the abdominal viscera are often attended with extravasation of various substances into the cavity; these may consist of intestinal contents, bile, urine, or blood. Besides the swelling which they cause, their presence irritates the surrounding parts, producing inflammation, constitutional disturbance, and sometimes even suppuration and a manifest fluctuation. If bile or urine be effused, the symptoms come out very rapidly, and are extremely urgent; but in other cases the symptoms are not so pressing. The resistance arising from the pressure of the respiratory muscles occasions the effused matters to be collected into one mass, and prevents them from becoming generally diffused over the cavity. When swelling, attended with local pain, fluctuation, &c. and the other symptoms which will attend the case, clearly indicate a collection of

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this kind, it may be opened by the surgeon.

Psoas abscess, is a collection of matter behind the peritoneum, in the cellular substance surrounding the psoas muscle. It forms in a very gradual manner, generally without inflammatory or febrile symptoms. There is a dull pain in the loins, and a slight weakness of the affected thigh. After some time, the matter, descending by its own weight, passes Poupart's ligament, and forms a swelling in the groin: or it may be present in the back just under the last rib. At this period the motions of the thigh are considerably impaired, particularly those in which the psoas muscle is concerned. There is an impulse in the tumour when the patient coughs, and the swelling is larger in the erect position. Sometimes disease of the vertebræ accompanies this affection. When the abscess bursts, the whole cyst falls into a state of inflammation; violent irritative fever ensues; and there is a copious suppuration, under which the patient gradually sinks. The most successful plan hitherto adopted is, that of opening the abscess as soon as it has presented fairly, by a pretty free incision with the abscess lancet; bringing the wound together, without allowing the introduction of any air, and closing it accurately with sticking plaster.

This is to be repeated when the matter has accumulated again, and thus the contraction of the cyst will be promoted; a third and fourth puncture may be necessary. Electricity and emetics of the metallic salts may be combined with this plan, to favour the absorption of matter; and a blister kept open by the savine serate will be an useful auxiliary means. Disease of the bone requires blisters, or issues in the loins.

Paracentesis abdominis is an operation performed for the discharge of dropsical fluid, and consisting merely in penetrating the parietes of the cavity by means of a trochar. The instrument is to be introduced three inches below the navel, in a perpendicular line drawn from that spot: and it should not be pushed more deeply, when it meets with no further resistance. Pressure by a belt or the hands of assistants should be kept up during the evacuation, as faintness is frequently produced by the sudden removal of the support from the abdominal viscera.

HERNIA

Is a tumour formed by the passage of any of the abdominal viscera from the cavity in which they are naturally contained, into a preternatural bag, formed by the protrusion of the peritoneum. The protruded portion of peritoneum is called the hernial sac. This peritoneal sac is covered by another investment, of various degrees of thickness, consisting probably, in great part, of the surrounding cellular substance, condensed into a membrane-like appearance, by the pressure of the hernia; in the same way as tumours acquire their investing cyst. In the inguinal hernia, this external coat of the sac possesses some tendinous fibres in its structure, derived from the aponeurosis of the external oblique, where it forms the ring. The chremaster muscle is also expanded on its surface; it consists usually of several layers, the division of which, in the operation, often leads the surgeon to suppose that he has opened the hernial sac. Scrotal ruptures often descend to various distances on the thigh, sometimes indeed even to the knee, yet the whole inner surface of the bag, in which all the loose viscera of the abdomen may be contained, is lined by a continuation of peritoneum; indeed, the hernial sac, taken altogether, is generally thicker and stronger in proportion to the size of the tumour, and to the duration of the complaint. The exterior covering is every where closely connected by cellular substance to the proper peritoneal sac. Hence the latter part is not returned into the abdomen when the contents of the swelling are replaced, but remains behind, ready to receive any future protrusion. When the parts have descended through the abdominal ring, the case is called a bubonocele, or inguinal hernia; if they are in contact with the testis, it is termed congenital. The crural or femoral is that which takes place under Poupart's ligament; and the exomphalos or umbilical rupture, occurs at the navel. The names of enterocele, epiplocele, and entero-epiplocele, are applied according as the swelling contains intestine, omentum, or both together. These are by far the most frequent forms of the complaint; yet there are several others, as ventral hernia, which takes place between the fibres of the abdominal muscles; hernia of the foramen ovale, ischiatic notch, &c. While the viscera descend and return freely, the complaint is said to be in a reducible state; but when, from increase of bulk, preternatural

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adhesions, or other causes, they are incapable of being returned, it is termed irreducible. An incapacity of reduction, arising from stricture in the opening through which the viscera have descended, brings it into the incarcerated or strangulated state. The causes of hernia are of two kinds; the occasional, or exciting, which consist of all those, by which the pressure of the abdominal viscera against the sides of the cavity is increased, as in straining, and all forcible actions of the respiratory muscles; and the predisposing, which favour the occurrence of rupture in particular individuals, as an unusually large state of the openings or lax condition of the margins of those apertures.

A *reducible hernia* is an indolent tumour, smaller in the recumbent position, larger in the erect posture; diminishing, or entirely disappearing, by means of pressure; large and tense after a meal, or when the patient is troubled with wind; soft and small in the morning, before he has taken any food; attended occasionally with a rumbling sensation, particularly on his return; and rendered tense when the patient coughs, so as to communicate an impulse to the hand of the examiner. Various visceral derangement, as colic, constipation and vomiting, are occasionally attendant. Uniformity and elasticity of the tumour, together with the rumbling noise, and the feeling of impulse on coughing, show that the case is an enterocele; but if the swelling be compressible, flabby, and uneven, free from tension on coughing, and slow in returning, the contents are omentum.

A reducible hernia, although not immediately dangerous, leads to many unpleasant consequences, from its constant increase in size, and the visceral derangements that ensue from this cause. It is also constantly liable to strangulation.

In a *strangulated hernia*, the protruded parts become inflamed, and this affection is propagated over the rest of the surface of the abdomen. Hence pain of the part, and tension of the belly, are early symptoms. An entire suppression of the fecal discharge is also a very leading character. Nausea and vomiting ensue; all the contents of the stomach, and afterwards those of the intestines, down to the stricture, being rejected. The whole system is deranged; there is great anxiety and restlessness, with a small and hard pulse, and cold extremities. At length hiccough supervenes, the pulse is hardly sensible, the respiration weak, and the whole body is covered by a cold and clammy sweat. Mortification and death now speedily succeed. The intensity of the symptoms, and their duration before the occurrence of the fatal event, are modified by numerous circumstances, as the age and strength of the patient, size of the rupture, closeness of the stricture, &c.; so that a case may terminate fatally within twenty-four hours, or it may be protracted for two or three weeks. Hence the strangulation has been distinguished into the acute and chronic.

The *treatment* of a reducible rupture comprehends the return of the protruded parts, and their retention within the abdominal cavity by means of an appropriate truss. Various proceedings were recommended by the older surgeons for producing a radical cure, as castration, caustic, the royal stitch, &c.; but as these expose the patient's life to the most imminent risk, without affording any greater chance of an effectual cure than the use of trusses would bestow, they have gone entirely into disuse. Herniary bandages are of two kinds; the elastic and non-elastic. The former are constructed with a piece of steel nearly encircling the body, and termed the spring, by means of which they maintain a constant pressure on the opening, through which the parts protrude.

If their use be continued for a sufficient length of time, it even affords a prospect of a radical cure. Since the constant pressure of the pad of the truss keeps the neck of the sac empty, and thereby brings on a gradual contraction and obliteration of its cavity. Non-elastic trusses are so inferior to the others, that they are now universally laid aside. As the best constructed trusses will not afford a certain protection from descent of the bowels, the ruptured person should avoid all great bodily exertions; and, if the hernia should descend, he should immediately go to bed, and send for surgical assistance.

As an *irreducible hernia* does not admit of the employment of a truss, the tumour must be supported by a suspensory bandage; and the patient, by temperance in diet, constant attention to the state of his bowels, and avoiding all great exertions, must endeavour to obviate the risk of strangulation, to which he is constantly exposed, and to prevent the increase of the tumour. Confinement to bed for a few weeks, with bleeding, mercurial medicines, purges, and low diet, has some-

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times caused irreducible hernia to go up; but great caution is necessary in adopting such a plan.

In the *treatment* of strangulated hernia, we attempt first to replace the protruded parts; which operation is technically termed the taxis. The patient should lie down, with his pelvis placed higher than the shoulders, with the thigh, in inguinal and crural hernia, bent and rolled inwards; the bladder being previously emptied, and a caution being given to abstain from coughing, holding the breath, &c. Gentle pressure must now be made on the tumour, and increased to a certain extent, but if possible, not so as to give pain. A general pressure may be made with both hands, or the tumour may be grasped with one, while the other is placed at the aperture, and employed in facilitating the entrance of the parts, or in keeping up those which have been already returned. The pressure should be exerted according to the course in which the parts have been protruded; *i. e.* upwards and outwards in the bubonocele, backwards and then upwards in the femoral hernia. Small herniæ are the most difficult of replacement; and the taxis succeeds also oftener in the early than the later periods of strangulation. It should not be persevered in when the rupture becomes painful. Mild purgatives and clysters should be used, even if the taxis succeeds. When we have not succeeded in replacing the parts, various means may be adopted in the treatment of a strangulated rupture. Those which are the most to be relied on are, bleeding, the warm bath, clysters of the decoction or smoke of tobacco, and ice, or other cold applications to the part. The former remedy must not be used indiscriminately, nor without a due attention to the patient's age and strength, nature of the symptoms, &c. Yet it should be employed with vigour when we have resolved on its use; and a considerable quantity should be drawn suddenly from a large orifice, to induce fainting. This, with the warm bath, and the employment of ice, or of the freezing mixtures, made by the solution of salts, are the means to be employed first; and if they fail, the tobacco clyster, made by boiling one drachm of tobacco for ten minutes in a pint of water, should be instantly tried. If this does not succeed after two or three attempts, the operation must be performed without delay. A smart purge of calomel and jalap will sometimes succeed in the early stage of strangulation, particularly in old and large hernia, where disorder of the bowels may have been the cause of strangulation, and where the symptoms are not very urgent. Opium is of use to allay the sickness. The surgeon should act with the greatest decision in these cases, and should particularly avoid all unnecessary delay. He should try at once the most powerful means, and operate as soon as it is found that they will not succeed. Surgeons are now universally agreed, that the danger of the operation arises chiefly from its being deferred until the local or general disturbance have proceeded to such a height, that a favourable result can hardly be expected; and that the chance of recovery is very considerable, when it is performed under more favourable circumstances. We shall describe the operation in speaking of inguinal hernia.

Inguinal hernia. The spermatic chord, in the male subject, and the round ligament of the uterus in the female, pass through a canal in the lower and front part of the abdominal muscles, called the abdominal ring. This canal is oblique in its course, commencing at the mid space between the spine of the ilium and angle of the pubes (upper or internal aperture,) running downwards and forwards, and terminating just over the pubes (lower or external aperture.) The upper opening is formed in a fascia, which ascends from Poupart's ligament, behind the abdominal muscles, and it is crossed above by the under edge of the internal, oblique, and transversalis muscles; the lower opening is formed by the tendon of the external oblique alone, and the distance between these is about two inches and a half. The inguinal hernia generally descends directly over the spermatic chord, which is consequently placed just behind the hernial sac; but it sometimes comes out directly from the abdomen, through the tendon of the external oblique, without traversing the canal of the abdominal ring; and here, consequently, the spermatic chord is on the outer side of the rupture. In the former and most frequent case, the epigastric artery runs along the inner edge of the mouth of the sac, while in the latter its course is on the outer side of the same part. The stricture may be situated, either at the upper or lower aperture of the ring, or in both.

Besides the common symptoms belonging to all herniæ, there are certain local characters which designate this species. The tumour descends from the abdominal ring to various distances in the

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scrotum; appearing first in the groin, and passing downwards in front of the spermatic chord. The testicle may be felt below or behind the swelling, which always appears to extend into the ring, and is hence distinguished from most other affections of these parts. It is much more frequent in the male than in the female subject. It must be distinguished from hydrocele, varicocele, sarcocele, hernia, humoralis, and bubo.

In operating for bubonocele, the patient's thigh should be bent, and the hair shaved from the swelling and neighbouring parts. An incision should be carried through the integuments, from an inch above the ring to the bottom of the tumour. The cellular substance intervening between the skin and hernial sac is then to be divided, layer by layer, with the knife and dissecting forceps; and the sac itself should then be opened with the edge of the knife held horizontally. A small portion of fluid is usually discharged at the aperture, which must be enlarged so as to expose the whole tumour.—The stricture, in whatever part it may be situated, must now be divided by the probe-pointed knife, conducted by the finger or director, and carried directly upwards, so as to cut the middle of the upper part of the contracted portion. This incision, which is technically named the dilatation of the ring, should not be carried further than is absolutely necessary for returning the parts. If the protruded parts are sound, and not adherent to each other, nor to the sac, they may be immediately replaced, the limb being always bent, and rolled inwards in this part of the operation, to relax the opening as much as possible. Intestine, although very much discoloured, will recover when placed in the cavity. If any adhesions exist, they must be destroyed by the knife, or finger, if they are not strong. The omentum is often found in a state in which it would be improper to return it. This viscus becomes thickened and hardened in an old hernia, so that its return would require a very free incision of the ring; and it is often discoloured by the inflammation consequent on the strangulation. In all such instances it should be cut away as far as it is affected, and the remainder returned into the abdomen, after any bleeding vessels have been secured by fine ligatures. The practice of tying the omentum in a mass, previously to cutting it off, is very pernicious, and has often been fatal. The wound should be closed by a sticking plaster, assisted, if necessary, with one or two points of suture. Common clysters, and mild purgatives, such as manna and Epsom salts, dissolved in mint water, should be taken after the operation, and the strictest regimen observed until the recovery is complete. Peritoneal inflammation, which is not an unfrequent consequence, must be treated by the most vigorous antiphlogistic means; of which copious and repeated venesections are the most important.

The operation above described would not be suitable in a case of large and old rupture. The extensive surface which must be exposed, and the violence necessary in separating adhesions, give rise to so much inflammation, that the consequences would be much dreaded; and the bulk of protruded parts has been sometimes so great, that they could not be retained in the belly after the operation. Here then the surgeon should take off the stricture without opening the sac, and push back as much of the contents as will pass up readily.

When mortification has taken place in the contents of a rupture, our conduct must be adapted to the circumstances of the case. It is sometimes found to have occurred in the protruded parts, when no symptom had previously led the surgeon to suspect it. But the mortification generally spreads to the superincumbent parts; the swelling becomes soft; the integuments deep red, livid, and afterwards black; the cellular membrane is emphysematous; the pulse sinks; lastly, the integuments give way, and wind and feces are discharged. Although these cases are generally fatal, yet their event is sometimes fortunate. We must chiefly trust to nature, and be careful not to interrupt those processes which she employs for the restoration of parts. The intestine is adherent to the parietes of the abdomen behind the ring; these adhesions are of great importance in the subsequent progress of the cure, and should therefore never be disturbed. If the intestine has not already given way, we may remove the stricture: where an opening has taken place, we may make such incisions through the sphacelated parts as will provide a free exit for the fecal matter. In either case mild purgatives and clysters will be proper to unload the bowels, and to determine the course of the feces towards the anus. The use of both these means, with the latter object, constitutes a very important part

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of the treatment of all cases of mortified intestine.

In cases where the mortification has not gone so far, the protruded gut may be affected either in one or more small spots; or it may have become mortified through a greater or less extent of its whole diameter. In the former case, it has been advised to leave the gut in the wound, after removing the stricture; or to return the intestine, and retain it in the neighbourhood of the ring by means of a ligature passed through the mesentery. The fear of an effusion of fecal matter into the abdomen, on the separation of the slough, formed the objection to the replacement of a mortified portion of gut; and the intent of the ligature placed in the mesentery was, to prevent the possibility of this much dreaded effusion, by keeping the sphacelated part opposite to the ring. Since, however, numerous facts have shown that neither of these events are to be expected, there can be no doubt as to the conduct required, where a portion only of the gut is affected with gangrene. We should replace it in the cavity, with the mortified portion towards the wound, and await the result of the operations of nature without interference.

When the whole diameter is mortified, the excision of the dead part, and the introduction of the upper into the lower end of the gut, where it is to be secured by ligature, has been advised. We have also been recommended to keep the two ends near the ring, by ligatures in the mesentery. We advise, that after dilating the stricture, the subsequent progress of the case should be left entirely to nature. The sloughs will be cast off; the ends of the gut are retained by the adhesive process, in a state of apposition to each other, the most favourable for their union; the wound contracts, and often completely closes, so that the continuity of the alimentary canal is perfectly re-established. The interference of art can only be prejudicial in this process. Perhaps the only step which would be justifiable, is that of making an incision in the sphacelated part; this will promote the evacuation of the alimentary canal, and afford considerable relief.

In all cases of mortified intestine there is considerable danger of the feces passing off constantly through the wound, by what is called an artificial anus. Here we must endeavour to alleviate those distressing inconveniences which arise from the involuntary discharge of wind and feces through the new opening, by supplying the patient with an apparatus, in which these may be received as they pass off.

Femoral hernia is formed by the protrusion of some of the abdominal contents under the inferior margin of the external oblique muscle (which part is called also Poupart's ligament): and the swelling is situated towards the inner part of the bend of the thigh. It is much the most frequent in women, and is generally very small; hence it may be mistaken for a swollen gland, unless great attention be paid to the symptoms. The precise point at which this hernia descends is the space left under the crural arch, between the femoral vein and the thin posterior edge of Poupart's ligament. The latter part has a broad insertion into the pubes, and this insertion ends in a thin and very sharp margin, turned towards the vein. The contents of the abdomen cannot escape in any other situation, because the crural arch is filled by parts going under it, and covered by a fascia extending over the iliacus internus muscle. The rupture first descends, and then comes forwards, to which we must attend in endeavouring to reduce it. The peritoneal sac is covered by a very complete exterior investment, as in the inguinal species. The spermatic chord, or round ligament, passes directly over the mouth of the sac, and the epigastric lies on its outer edge. The stricture, which is always very close, should be relieved, by detaching the thin edge of Poupart's ligament from the pubes.

Umbilical hernia, exomphalos, or omphalocele, is formed by the protrusion of the viscera through the tendinous opening termed the navel. An elastic truss for this rupture is described by Mr. Hey, and is the best hitherto contrived.

There is nothing peculiar in the treatment or operation, nor in those of the ventral and congenital kinds. The surgeon, however, in the latter, will be aware that the hernial contents lie in the same bag with the testis, in consequence of the communication that exists in one period of the fetal existence between the abdomen and tunica vaginalis testis never having been closed. Hence, in such a case the testis cannot be felt distinctly from the hernial swelling.

Hydrocele is a collection of watery fluid in the cavity of the tunica vaginalis testis, or in the spermatic chord. The former is exactly similar in its nature to the dropsical affections of the peritoneum,

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pleura, or pericardium. The swelling is colourless, smooth, and pyriform; extending slowly and gradually upwards from the lower part of the scrotum; fluctuating, and incapable of reduction or diminution; often there is a degree of transparency, so that the light can be discerned through it; but as the tunica vaginalis is frequently thickened, neither this circumstance, nor the fluctuation, can be entirely depended on. The testis cannot be felt, but the spermatic chord may be discerned clearly, in a natural state, above the swelling. The cure is either radical, or palliative: the latter consists in letting out the fluid with a trochar, after which a piece of soap plaster may be applied, and a bag-truss worn. The fluid accumulates again. In the radical cure, the hydrocele should be tapped with a trochar at its anterior and inferior part, and as soon as the fluid is entirely discharged, the cavity of the tunica vaginalis is to be distended to its former dimensions, with an injection composed of two parts of red wine, and one of warm water. The injection may remain in the part about five minutes, after which it is to be discharged through the trochar. The consequence of this treatment is a considerable inflammation of the part, terminating in the effusion of coagulating lymph, and the consequent obliteration of the cavity of the tunica vaginalis. The inflammation is to be treated like hernia humoralis, if it runs too high.

Hydrocele of the chord may either consist of an effusion of water into the cellular substance, or of a single cyst of various magnitude. If the former prove troublesome, a free incision through it seems to be the only means of treatment; the latter may be treated by the port wine injection.

Hæmatocele is a swelling of the scrotum, caused by the effusion of blood into the tunica vaginalis. Its most common cause is the wound of a blood-vessel in tapping a hydrocele: the water, as it flows off, is generally discoloured, and the swelling soon after regains its former magnitude. Discutient lotions, as that of the sal ammoniac, or cerussa acetata and vinegar, will generally cause the absorption of the blood; camphorated liniments and mercurial ointment may also be employed, if the case be obstinate. Should these means fail entirely, an incision must be made through the integuments and tunica vaginalis, and the blood removed.

Sarcocele is a chronic fleshy enlargement of the testicle. It exhibits very different appearances in different cases. It may present a vascular mass of uniform appearance, without enlargement of the chord, or any very painful symptoms. It may have a white caseous substance intermixed with this; or it may contain several cells, filled with different coloured fluids. But it is also liable to scirrhus and cancer; in which case it forms a hard brownish mass, with portions of a membranous or gristly firmness intermixed; attended with severe pain darting along the chords to the loins; and having an unequal knotty feel. The chord too becomes enlarged, and the health is affected. Sometimes this kind of sarcocele forms a foul ulcer, with bleeding fungus, &c. When the chord is affected the disease generally appears in the inguinal glands, and soon after destroys the patient. A mild sarcocele may be treated with leeches and discutient lotions, setons, and mercurial frictions, with the view of dispersion; but if these fail, castration is the only remedy The same means should be immediately employed in a case of scirrhus; for that affords no hope of cure. The operation would also be too late, if deferred until the chord has become indurated and knotty. Chronic enlargements of the testicle are sometimes attended with an accumulation of limpid fluid in the tunica vaginalis; and the disease is then termed hydro-sarcocele.

The operation of castration consists in making a longitudinal incision from the abdominal ring to the bottom of the tumour; in dissecting down each side of the spermatic chord, so as to be able to take it between the finger and thumb; in dividing the chord, and tying any bleeding vessels on its surface; and then in dissecting away the testis, by free sweeps of the knife, from the scrotum. All bleeding vessels should be carefully secured; the edges of the integuments retained by two or three points of suture, and in their intervals by sticking plaster; over which a pledget, compress, and T bandage, are to be applied.

Varicocele is an enlargement of the veins of the scrotum, or spermatic chord, attended with a very peculiar feel, and causing a tumour, which is generally indolent, but may be troublesome. It is often mistaken for omental hernia; and sometimes is attended with wasting of the testicle. If the swelling be painful, leeches, saturnine and discutient lotions, purgative medicines, horizontal position,

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and a bag-truss, are proper. The varicous veins have been tied with success in very obstinate cases.

Hernia humoralis is an inflamed state of the testicle, in which that gland is much enlarged, and very painful. The scrotum is distended and red, and the pain shoots into the loins Irritation of the urethra is the most frequent cause, and particularly that which takes place in gonorrhœa. The unpleasant symptoms of the latter complaint cease when the testicle swells, and often recur when the hernia humoralis abates. A recumbent posture, frequent application of leeches, saline purgatives, cold saturnine, or discutient washes, or in some cases poultices, and in all instances a suspensory bandage, are the means of relief. Camphorated mercurial ointment should be rubbed on the epididymis, when a hardness of that part remains.

Cancer scroti, or chimney-sweeper's cancer, commences in the scrotum with an ulcerated wart, or rugged ill-looking sore, with hard and elevated margin. It penetrates the scrotum, affects the testis, ascends along the chord, contaminates the inguinal glands, and terminates the patient's existence in a most deplorable way. Extirpation in the early state is the only effectual mode of treatment.

Gonorrhœa is the discharge of a mucous or purulent fluid from the urethra, occasioned by the application of infectious matter from another subject labouring under the disorder, and generally communicated by coition. The urethra may be irritated so as to furnish a preternatural quantity of secretion by other causes; as strictures, use of bougies, &c. It generally comes on from six to twelve days after the infection; and commences with an itching and fulness of the mouth of the urethra. A discharge follows, first of a watery and transparent kind, and then becoming thicker and white, yellow or greenish. The glands swell, and the membrane at the mouth of the urethra becomes smooth, red, and swollen. An acute scalding pain is experienced in making water, which is voided frequently, and in a diminished stream. Troublesome erections are experienced at night. Various sympathetic affections often attend; as pain and soreness over the whole pelvis, in the scrotum, testicles, anus, &c.; enlargement of the inguinal glands, forming sympathetic bubo, and irritability of the bladder. It has been much disputed, whether the matter of gonorrhœa and chancre be the same, and consequently whether the constitution can be affected from a gonorrhœa. But at present most surgeons are inclined to support the negative side of the question; and all act in the treatment of the complaint on this supposition.

In ordinary cases the affection does not seem to extend more than about two inches along the urethra. The complaint increases in violence for about three weeks, and then gradually declines; a discharge often remaining when the other symptoms have entirely subsided, and being then termed a gleet. There is little power of stopping the course of the complaint, at least without great risk of inducing hernia humoralis; so that the safest plan is to palliate. Occasional saline purges, abstemious regimen, and copious draughts of diluting and mucilaginous liquors, are proper with this view. Suspension of the testicles is useful as a precaution against hernia humoralis. Cold applications to the penis. After a few days, astringent injections may be employed, often with the effect of lessening the duration of the discharge considerably. Zinc. vitriol. gr. ijss. in two ounces of water; or hydr. muriat. gr. j. in eight ounces of water, will do for the beginning; but their strength may be increased. Opium and antimony, where the symptoms of irritation are very considerable; balsam copaivæ is also very useful.

The gleet which remains after a gonorrhœa is not infectious, although very troublesome. Astringent injections may be tried for it; as hydr. mur. gr. ij. in aq. distillat. ℥ viii or zincum vitriol. or cupr. vitriol. in larger proportions. Balsam copaivæ or tinct. cantharid. may be taken internally.

Chordee is an inflammation, attended with extravasation of coagulating lymph into the corpus spongiosum urethræ, or corpora cavernosa penis, which renders the penis curved in its erect state. Bleeding by leeches, fomentations and poultices, with the antiphlogistic regimen generally; and afterwards camphorated mercurial ointment.

Sympathetic bubo should be treated as a case of common inflammation. Affection of the bladder may be combated by the warm bath, venesection, leeches, and fomentations to the perineum and bladder, and opiate clysters

Phymosis and Paraphymosis. In the former the prepuce is so contracted, that it cannot be withdrawn over the glans; while in the latter it cannot be drawn forward from behind the glans. The irrita-

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tion of chancres, gonorrhœa, &c. is the common cause of these affections; but some persons are born with a phymosis. Frequent injections under the prepuce are necessary in phymosis, which need not prevent the use of mercury if it is required. If the contraction be so great as to confine the matter, and absolutely prevent its discharge, the prepuce may be slit open, but not otherwise, in the inflamed state. When the complaint has subsided, and the contraction still remains, the following operation may be performed. The surgeon grasps the prepuce with a pair of harelip forceps, leaving out as much of the outer fold as he wishes to remove, and cutting this away at one stroke of the knife. He then slits up the inner fold with a crooked bistoury passed in a director.

In paraphymosis the glans can generally be returned by pressing the blood out of it, after immersion in cold water, and drawing forwards the prepuce. Leeches may be applied to the glans to diminish its bulk. If these means do not succeed, the stricture must be cut through.

Amputation of the penis is necessary in cancer of that organ; but it should be done before the glans are affected. One stroke of the knife is sufficient for the purpose, after which the bleeding vessels must be secured.

Strictures in the urethra are contractions of the canal; which may be either temporary, when they are called spasmodic; or permanent, in which case there is a projecting ridge of the membrane, or a continued contraction, occupying some length of the canal. The latter are also subject to attacks of spasm from inflammation, &c.; and vary in their state under different circumstances. If there be only a single stricture, it will be generally found at the bulb of the urethra; that is, about six and a half or seven inches from the mouth of the urethra; and where strictures are situated nearer to the end of the penis, there is almost always one in the former part. The symptoms of the complaint are, diminished stream of urine, which is voided more frequently than is natural, and with difficulty; gleet, nocturnal emissions, impeded ejection of the seminal fluid in coition; irritability of the bladder, which secretes a mucous fluid. Sometimes there is a complete paroxysm of fever; and occasionally swelling of the testicle. Strangury and total retention of urine are sometimes the consequence of a stricture, which becomes affected with spasm from some occasional cause.

Our first object in treating strictures is to ascertain the number and situation of the contractions. The bougie should be curved to the requisite degree (which is necessary in all cases where these instruments are introduced) and oiled before its introduction. The surgeon holds the glans penis lightly with the fore-finger and thumb of the left hand, just under the corona glandis, and introduces the bougie with the right hand, carrying it forwards gently, and drawing the penis upwards, so as to make the urethra tense. When he meets with an obstruction, he waits a little, and tries again. He should make a mark with the nail on the bougie, opposite to the end of the urethra, if he cannot pass a stricture; and then try a smaller instrument The same plan must be pursued, until all the contractions are ascertained. If he makes this examination with a soft white bougie, he may get an impression of the stricture by pressing gently, which will be of service in the subsequent treatment. For the cure of the complaint common bougies may be used; or they may be armed with caustic.

The common bougie acts mechanically by dilating the contracted portion. The largest instrument that the urethra will admit should be passed into the bladder daily, and left there for ten minutes at first, gradually lengthening the time. It should be secured by tying it to the end of the penis. The size of the bougie should be increased, as the strictures dilate.

Where caustic is used, a small piece of argentum nitratum is inserted in the end of a bougie, and surrounded laterally by its substance. This is termed an armed bougie. In using this method, we ascertain first how large a common bougie will pass to the stricture, and mark accurately the distance of the contraction; then take a caustic bougie of the same size, and mark the distance on this also. We then carry it pretty quickly down to the stricture, against which we hold it steadily, at first for a short time (less than a minute) but afterwards longer. This is to be repeated every other day, and to be practised successively with the different strictures that are met with. Mr. Whately has recommended a peculiar mode of employing caustic. He breaks a piece of kali purum, with a hammer, into bits, of which the largest should not exceed a pin's head, and keeps these in a phial with a ground stopper. He passes a bougie through the stricture, and marks the situation of the contraction. In the end

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of this he makes a small hole with a pin, inserts a bit of the kali, smaller than a pin's head, and covers it with lard. He passes his bougie, properly curved, down to the stricture, and lets it rest for a few seconds, that the kali may dissolve; he then urges it about one-eight of an inch forwards, allows it to rest, and then passes it on about as much further. He now withdraws it to the beginning of the stricture, and passes it through again once or twice. This is to be repeated every seven days, the size of the bougie being increased as much as the stricture will admit. Mr. Whately adopts this plan, from supposing that the membrane of the urethra is diseased for some extent.

A new passage is sometimes formed by the use of bougies. Here all instruments should be laid aside, if the circumstances admit, to give an opportunity for the parts to recover.

Fistula in perineo. When the urethra is very much obstructed, nature often endeavours to procure relief by ulceration on the inside of that part of the urethra, which is between the stricture and the bladder. Hence the urine insinuates itself into the cellular substance of the perineum, scrotum, &c. causing suppuration and mortification. If the patient survive, the sloughs are detached, leaving a free communication between the urethra and the external surface: and the openings thus produced, by which urine is evacuate, are called fistulæ in perineo. The treatment consists in removing the stricture, which is the cause of the complaint; and this must be attempted both by the caustic and common bougie. If the fistula does not heal, when the urethra is perfectly restored to its natural dimensions, it should be laid open like any other sinus which does not seem disposed to heal. A catheter, or staff, having been passed into the bladder, a director is introduced along the sinus, until it meet the former instrument; then it will be easy to divide the sinuses with the crooked knife. An elastic catheter should be worn until the wound is healed, which should be dressed from the bottom. The treatment of the complaint, which terminates in a fistula in perineo, will be considered under the next head.

Retention of urine. When the evacuation of urine is prevented by any particular cause, the bladder becomes remarkably distended. Its fundus ascends towards the navel, and forms a hard circumscribed swelling above the pubes, while the lower portion of the viscus bulges towards the rectum. Violent pain and straining, tension of the abdomen, cold sweats, anxiety, &c. are attendant symptoms. When the cause of the retention does not close the urethra, and it has proceeded to a considerable extent, the urine comes away by drops through the natural passage, leaving the bladder still distended. If the canal, through which the urine ought to flow, be obstructed, inflammation and ulceration or sloughing ensue. When this happens in the urethra, fistulæ in perineo are the consequence. But the bladder itself may slough and burst. Retention of urine arises from the following causes. Weakness, or paralysis of the bladder, inflammation of this viscus or of the adjacent parts, a spasmodic affection of the urethra, or some actual contraction of the passage.

The paralytic retention of urine may be caused by an injury to some part of the spinal marrow; by an over distention of the bladder, arising from retaining the water too long after an inclination is felt to void it, &c. Two objects are to be accomplished in the treatment; to draw off the fluid distending the bladder, and to restore the natural contractile power of the viscus. The use of the catheter at certain stated periods accomplishes the first of these; the internal use of cantharides, blisters to the sacrum, pubes, or perineum, cold water thrown on the hypogastrium, cold bath, &c. promote the second indication. The catheter must be used regularly and frequently, until the cure is completed.

The retention arising from enlargement of the prostate belongs to this division. A neglect of the patient to obey the natural calls to void his urine is the first cause; and the regular use of the catheter is the most efficacious means of cure.

Use of the catheter. This instrument is either inflexible, and made of silver, or flexible and elastic, which is composed of the elastic gum. There are also flexible catheters made a of fusible metal, and others composed of the bougie plaster; but the former are employed the most frequently. The elastic catheter is less irritating to the urethra than a silver tube, and it can be introduced in cases where a metallic inflexible instrument will not pass. The most favourable posture for the introduction of the catheter, is that in which the patient lies down, with his pelvis at the edge of the bed, and the legs hanging to the ground. The corona glandis should be held between the thumb and

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fore-finger of the left hand, so as to avoid compressing the corona glandis. The catheter, well oiled, should be introduced, with the concavity towards the abdomen, until its point has nearly reached the bulb. The handle should now be brought slowly forwards, between the patient's thighs; and the point will consequently describe that portion of a circle which is necessary for its entering the bladder. In the latter stage of the operation, the penis, which before had been drawn upwards, should be allowed to sink down. If an impediment is met with in any direction, let the point be withdrawn a little and then pushed gently onwards, according to the course of the urethra; but force should be avoided by all means. The fore-finger of the left hand, introduced into the rectum, will sometimes facilitate the operation. When the prostate gland is enlarged, the urethra turns upwards very suddenly, just behind the pubes; hence the end of the catheter should be more bent upwards. It has also been found that, by withdrawing the stilet of an elastic gum catheter for a small distance, the instrument itself becomes more curved; and by this means the point of the instrument may be elevated in the urethra in the due direction. Many surgeons introduce the catheter as far as the perineum, with its convexity towards the abdomen; then keeping the point stationary, they make the handle describe a semicircular movement upwards, so as to bring the concavity of the instrument towards the pubes; after which the operation is finished as in the former method.

When the retention of urine arises from an inflammatory cause, the nature of the disorder is entirely altered. Strictures in the urethra, when very bad, and irritated so as to fall into spasmodic contraction, are the most frequent source of this kind of retention. However, virulent gonorrhœa, bad piles, injuries of the perineum, fistula in ano, and the absorption of cantharides from blisters, may have the same effect. The treatment of such cases must be of the antiphlogistic kind; venesection, leeches to the perineum, warm baths, fomentations to the perineum and hypogastric region; opium by the mouth, and in clysters, are consequently to be employed. The use of the tinctura ferri muriati internally is also a very powerful assistant in such affections. The patient may take fifteen drops every ten minutes until it acts. A common clyster will often suffice in slight cases.

If none of these methods succeed, and the catheter or bougie cannot be introduced, it becomes necessary to puncture the bladder; which operation is neither dangerous nor painful, and fails in success, probably, because it is employed generally too late. It may be done from the perineum, pubes, or rectum. The two latter places are so much preferable to the former, that we shall describe those operations only. When the prostate gland is enlarged, (and such a case often requires the paracentesis vesicæ) the operation must be done above the pubes; if the patient should be fat, it would be preferable to puncture from the rectum. When all circumstances are equal, experience has not hitherto discovered any very decisive advantage in either of these methods over the other.

When the distention of the bladder can be clearly felt above the pubes, the surgeon may plunge a curved trochar directly into its cavity, about an inch above the bone, as in the paracentesis abdominis. He should remember to direct the point of the instrument in the axis of the bladder; and not to urge it forwards when the resistance to the point ceases. Then the stilet should be withdrawn, and the canula pushed onwards. The latter part must be confined in its situation, and should remain in the bladder until the natural passage is re-established: or, after a few days, an elastic catheter may be introduced through it, and the canula withdrawn. If the bladder cannot be felt so distinctly, the surgeon may dissect down to its surface before he penetrates it with the trochar.

In operating from the rectum, a long curved trochar should be employed. The two first fingers of the left hand serve as a direction to the instrument, which is firmly held in the right; and should be passed through the very middle of the projection caused by the distended bladder, care being taken to accommodate its direction as much as possible to the axis of the bladder. After forty-eight hours the canula may be withdrawn, and the artificial opening will serve until the natural passage is restored.

In women, the bladder should be tapped above the pubes, although it might be done from the vagina.

If the surgeon should not be called in until the urethra has ulcerated, and the urine becomes diffused, it will be his duty to make free incisions, particularly in the perineum, for the discharge of that fluid, and to use those general means which are

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likely to allay the constitutional irritation. He must then wait until the operations of nature have separated the sloughs caused by the urine, endeavouring, however, to introduce an elastic catheter, where he should allow it to remain. Poultices, fomentations, and the warm bath, should be resorted to, if there are any appearances of inflammation; and abscesses, or accumulations of urine, should be opened early and freely.

Incontinence of urine. Sometimes this fluid dribbles away without any sensation of the patient. Here paralysis of the bladder is the cause, and may be induced in various ways, as from injuries of the spine, over distention of the organ, &c. In the latter case, the urine should be carefully drawn off at regular intervals; cold bathing, bark, blistering the sacrum or perineum, electricity, tincture of cantharides internally, &c. will be of service.

Sometimes the patient can hold his urine to a certain degree, when an irresistible propensity to evacuate it comes on. Here irritability of the bladder is the cause, and may be induced by bad piles, fistula in ano, &c. Opium, the warm bath, fomentations, diluting drinks, &c. may be resorted to, when no obvious cause appears.

Imperforate vagina. Sometimes the labia have their opposite surfaces grown together, leaving perhaps merely a small opening, through which the urine is imperfectly discharged, but marked with a line, showing the proper distinction. This may be congenital, or the effect of disease. Sometimes a thin membrane closes both the meatus urinarius and vagina in newly born children. In both these cases the use of the knife is necessary; and lint should be interposed between the divided surfaces. There is another form of the same mal-formation, in which the vagina alone is closed; and no symptoms appear until puberty, when the menstrual discharge does not flow. The uterus swells, and at last a kind of labour pains come on. Here the membrane must be divided to discharge the accumulated menses, and the edges of the cut kept asunder.

Imperforate anus. The part may either be closed by a membrane, or be too contracted to allow the fecesto be evacuated. It may be rightly formed at its outer part, but terminate in a cul de sac; or there may be no vestige whatever of anus. In the first species, a division of the membrane is the remedy; and in the second, a dilatation of the contracted part by the crooked bistoury. If an obstruction should be discovered within the gut, it may be perforated with the trochar, introduced according to the course of the intestine. The latter species is attended with very little hope of saving life. The surgeon may cut in the situation of the anus, and follow his dissection along the sacrum, in order to find the end of the gut, which, when found, should be punctured.

Fistula in ano. Any formation of matter near the anus is very likely to terminate in this complaint; the suppuration extends in the fat and cellular substance round the rectum, and sinuses form, having small external apertures, and seldom healing without an operation. The commencement of the disorder may be a phlegmonous abscess, attended with considerable sympathetic fever; or it may have a more erysipelatous character, spreading more widely, being more superficial, and attended with depression of the powers of the constitution. The former is seen in young, strong, and healthy subjects; the latter in weakened, intemperate, and unhealthy constitutions. The parts in the neighbourhood of the disease are often affected; and hence retention of urine, strangury, prolapsus and tenesmus, piles, &c. are produced. The complaint sometimes begins in an induration of the skin near the anus without pain. This hardness gradually softens and suppurates. The matter may either point in the buttock, at a distance from the anus, or near this latter part, or in the perineum. It may escape from one opening, or from several. Sometimes there is not only an external aperture, but another internal one, communicating with the cavity of the intestine.

A soft poultice and fomentations are the best means of treating these abscesses; which, if they are phlegmonous, should not be opened until the skin has become thin; but, when they are of the erysipelatous kind, should be punctured immediately, to prevent any further extension of the malady. The general treatment must correspond with the nature of the constitutional disturbance. In all abscesses about the anus, the incision should comprehend all the skin covering the matter, as the cavity is then most likely to fill up from the bottom. The dressing should be small in quantity, light, and unirritating. If, however, the case passes into a fistula, it will be necessary to make it an open wound, by cutting through the rectum from the end of the

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hollow to the anus. A probe having been introduced at the external opening of the fistula, serves as a director for the probe-pointed knife, which will be felt in the rectum by the surgeon's left fore finger. If the fistula should not have penetrated the gut, the bistoury should be pushed through its side. The probe may now be withdrawn, and the operation completed by bringing the knife out with its point applied to the finger which was in the intestine; and thus all between the edge of the knife and the anus must be divided. A soft piece of lint should now be placed in the wound, and remain until it is loosened by suppuration, and all the future dressings should be mild and unirritating. The callosities, of which surgeons have complained so much in these cases, arise from injudicious treatment, and particularly from the use of caustic and stimulating applications.

Prolapsus ani. The internal coat of the gut may be protruded through the sphincter; or a portion of the intestine with all its coats may descend. Causes which weaken the sphincter, and such as force the intestine downwards, contribute to this affection. Costiveness, tenesmus kept up by hemorrhoids, ascarides, fistula in ano, stone, &c. are of this kind. The cause should be removed when that is practicable. The gut must be replaced, but previously clysters, fomentations and poultices, or leeches and cold washes, are necessary. Horizontal posture, and avoiding costiveness, are very important points. A compress and bandage may be necessary to retain the replaced gut; and astringent clysters have been advised. If the protruded part has become indurated, thickened, and painful, and will not admit of reduction, it may be extirpated. Sometimes an introsusception, commencing at the cæcum, has protruded at the anus. This case is quite beyond the powers of art.

Prolapsus, inversio, and *retroversio uteri,* are considered under the article MIDWIFERY.

LITHOTOMY.

The existence of a stone in the bladder causes various symptoms in the bladder itself, and others in neighbouring parts. The former are, frequent inclination to void the urine, which sometimes stops suddenly from the stone mechanically obstructing its passage; pain in making water, and particularly after the discharge, from the bladder contracting on the foreign body; mucus, and sometimes blood in the urine, and pain on exercise. The latter are an uneasiness and itching at the end of the penis, leading the person to draw and elongate the prepuce; sense of weight in the perineum; tenesmus; numbness of the thighs, &c. These symptoms come on in fits. In order to ascertain the fact, a solid steel instrument, shaped like a catheter, and called a sound, is introduced into the bladder, where its point, meeting the stone, gives decided information to the surgeon. It must be moved in various directions after its introduction, as it may not immediately or easily come in contact with the stone. The operation should never be performed unless the stone can be plainly felt before the operation: the rectum should be previously emptied, but it is more advantageous for the bladder to be full. The patient is to be placed with his pelvis at the edge of a table, and the staff introduced into the bladder. The thighs and legs are then bent, so as to enable him to grasp the soles of the feet with his hands, and the limbs are retained in this position by broad garters, doubled and placed by means of a noose round the wrists, carried over the back of the hand, and inside of the foot; then brought up again, and continued round the wrist and ankle, and firmly tied. The staff is shaped like a sound or catheter, and has a groove for conducting a cutting instrument into the bladder. An assistant standing on the patient's right side holds the handle of the staff with one hand, making its convexity project in the perineum, and draws aside the scrotum with the other. An incision should be made through the integuments, commencing on the left side of the raphe of the perineum, just opposite to the membranous part of the urethra, and continued obliquely downwards and outwards for about three inches between the anus and ischium. The transversalis perinei should then be cut through, and the membranous part of the urethra freely opened, so as to expose the groove of the staff. The beak of the gorget is now introduced into the groove, and the operator takes the handle of the staff into his left hand, holding the gorget in his right. He then thrusts the gorget into the bladder, keeping its beak in close contact with the groove of the staff, and bringing the handle of the latter instrument downwards and forwards, in order to raise its point, and make its direction coincide with the axis of the bladder. The cutting edge of the gorget, by this mode of introduction, divides the prostate gland and neck

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of the bladder. This instrument is used of various figures by different surgeons. The best perhaps is that in which the cutting edge of the instrument extends horizontally from its beak, from which it may be carried to the length of three quarters of an inch. A good anatomist may perform the operation with a scalpel, which instrument will enable him to divide the parts with more exactness. The escape of the urine shows that the bladder is opened. The staff should now be withdrawn, and a proper pair of forceps passed along the concave surface of the gorget into the bladder, for the purpose of seizing and extracting the stone. This instrument is first employed as a probe to ascertain the position of the stone, which being accomplished, the blades are to be expanded, and moved in such a direction as to grasp it; and the instrument, very firmly held, may then be slowly withdrawn, being moved from side to side in order to bring the foreign body through the wound. If the stone be very large, it may be expedient to dilate the wound with a curved knife, or to break the stone in the bladder, by means of forceps constructed for that purpose. In the latter case, and in instances where the stone is broken in the operation of extracting it, the bladder should be washed out with lukewarm water, to remove any small fragments. Careful examination with the finger is necessary, to ascertain that nothing is left behind. A compress of lint, pledget, and T bandage may be put on, but they are of little service, as the urine escapes through the wound. Since peritoneal inflammation is the occurrence most to be feared after lithotomy, great attention to the state of the abdomen is required, and on the least indication of such a consequence, venesection, leeches, warm bath, warm fomentations, blisters, emollient clysters, and purgatives, should be resorted to, according to the symptoms.

This mode of performing lithotomy is called the lateral operation; it has been performed with an instrument called a lithotome caché, instead of the gorget. This is a long narrow knife, concealed in a grooved instrument, which is passed into the bladder along the groove of the staff exposed in the way already described. A spring being then compressed, makes the knife rise out of the groove, and the instrument is withdrawn in this state, cutting the prostate and bladder as it recedes. In former times an opening has been made into the bladder above the pubes, particularly in young subjects; this was called the high operation, but has long been disused.

Spina bifida is a swelling situated on the spine of infants at the time of birth. It consists of a sac filled with an aqueous fluid, and composed of the integuments and the membranous sheath of the spinal marrow protruding through a fissure caused by a deficiency in the bones. The subjects are generally weak; diarrhœa, paralytic state of the lower limbs, and inability to retain the urine and feces, often attend. The tumour enlarges, inflames, and ulcerates, and then the patient dies; but this occurrence takes place at different periods. No treatment has hitherto been of any service.

Caries of the vertebræ. This is a disease of the spine, generally attended with a degree of curvature, and with a paralytic state of the lower limbs. It is most frequent in children, but not peculiar to them. The affection of the limbs is first observed. There is an unwillingness to move about, and the patient often trips and tumbles. The legs involuntarily cross each other. The power of directing the feet to any exact point is then lost, and the natural sensibility of the legs and thighs becomes much impaired. At this time there is usually a more or less marked bending of the spine forwards, occasioning an angular projection of the spinous processes. The general health becomes much affected, and the urine and feces are discharged involuntarily. The cause of all these complaints is the diseased state of the vertebræ, which are softened, and more or less absorbed, affecting the inclosed medulla spinalis. In the progress of the disorder the bodies of three or four vertebræ may be entirely destroyed, so as to lay bare the front of the spinal marrow. We are indebted to Mr. Pott for proposing the only treatment that has ever afforded relief in this affection, *viz.* that of making an issue on each side of the diseased portion of the spine. This can be best accomplished with the calx cum kali puro. Several pieces of sticking plaster are to be stuck together, and a hole should then be cut in the mass, corresponding to the size of the intended issue. This is applied on the back, and a thin layer of the caustic placed in the hole, and covered by another piece of plaster. In four or five hours the plaster should be removed, and a poultice applied until the eschar separates. The issue is then filled with peas or beans, confined by adhesive plaster, over which pressure should be made, by firmly binding on a

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piece of sheet lead. The issues must be kept open until the complaints have entirely disappeared.

AMPUTATION.

In whatever part this is performed, the surgeon's object is the same, *viz.* to save enough of the surrounding soft parts to cover the extremity of the bone, and enough of skin to cover the whole. The stump is always treated as a wound which should be united by the first intention; its sides are therefore brought together, and retained in apposition by straps of adhesive plaster, and appropriate bandages. By this, which is the improved method of modern surgery, introduced by Mr. Alanson of Liverpool, the wound made by removing a thigh is often agglutinated in forty-eight hours, and the patient consequently escapes the dreadful pain and irritation, and vehement sympathetic affection of the constitution, which almost invariably attended the old practice of dressing the stump with dry lint as an open wound, and consequently healing by means of granulation and cicatrization, instead of adhesion.

In *amputation of the thigh*, surgeons used to cut at once down to the bone, and saw that through; but in order to save more soft parts, and thereby to avoid the projection of the bone, which commonly attended that method, the double incision was devised; by which the skin and muscles are divided separately. More difficulty is experienced here than in any other amputation, in saving muscles enough to cover the bone, which, in this particular instance, is especially desirable, from the pressure which the end of the stump must experience in supporting the weight of the body. The sound leg should be tied to the table, and the tourniquet applied on the inside of the thigh. The limb should be cut off as near to the knee as possible. A circular incision should then be made by the surgeon, standing on the outside of the limb, through the skin and adipous substance. The integuments should be drawn upwards by an assistant, and any cellular connection that prevents their retraction should be divided. A cut should now be carried through the loose muscles, at the part to which the skin has been withdrawn, and when they have retracted, those which are fixed to the bone should be divided at the point to which the former had retracted. The latter may be separated from the surface of the bone, for a short distance, by a common scalpel, to allow of the bone being sawed higher up than it could be otherwise. This part of the operation should follow, the surface of the wound being kept out of the way of the saw, by means of a retractor, which is a piece of linen, somewhat broader than the stump, torn at one end, in its middle part, to the extent of about eight or ten inches. It is applied by placing the exposed part of the bone in the slit, and drawing the ends of the linen upward on each side of the stump. Besides defending the surface of the wound from the teeth of the saw, the retractor will undoubtedly enable the operator to saw the bone higher up than he otherwise could do. The femoral artery should be drawn out by means of a pair of forceps, and tied separately; other large arteries should also be secured, without including any of the surrounding soft parts. Smaller branches must be taken up with the tenaculum. It is necessary to slacken the tourniquet, in order to discover the vessels. The wound should then be thoroughly cleansed from all coagulated blood, by means of a soft sponge and water, and one end of each ligature removed. The skin and muscles are now to be placed over the bone, in such a direction that the wound shall appear only as a line across the face of the stump, with the angles at each side, from which the ligatures should be brought out. The skin is supported by long strips of adhesive plaster, applied at right angles to the line of union of the wound; the ligatures are guarded by lint spread with spermaceti-cerate; and a linen roller is carried round from above downwards, two cross pieces having first been put over the end of the stump. The dressings should not be moved for four days.

In *amputating the leg*, the bones should be sawn through, about four inches below the patella. The tourniquet is applied in the lower part of the thigh. After cutting through the skin, which should be drawn upwards, it must be reflected from the flat surface of the tibia, and front of the leg, so as to cover those parts which could not be covered by any large muscle. The calf is then to be cut through, by an oblique incision slanting upwards; the rest of the muscles, and the interosseous ligament, should be divided by a double-edged knife, called a catlin, and the bones sawn, after the previous application of a double tailed retractor.

In *amputating the arm* or *fore-arm*, we should preserve as great a length of the limb as the case will allow.

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Amputation of the shoulder-joint has been done in various ways. An incision should be carried through the skin and deltoid muscle down to the bone, from the front of the joint, a little below the clavicle, obliquely downwards and outwards. The deltoid should then be turned up so as to expose the head of the bone, which must be brought entirely into view, by dividing the orbicular ligament all round. One cut of an amputating knife will then separate the limb. The axillary artery should be immediately tied. This vessel must be firmly compressed by an assistant, above the clavicles, during the whole of the operation.

The *fingers* and *toes* should be removed at the joints. Make a circular incision through the skin, about one third of an inch below the articulation; draw the integuments up, and cut through one lateral ligament of the joint, which you can then dislocate. The remaining connections are easily divided. Bring the skin together over the end of the bone. If you amputate at the first joint, make two cuts, one at the back, and the other towards the front; these must meet when the bone is removed. It is sometimes necessary to tie the arteries.

Paronychia, or *whitlow*, is an abscess occurring about the nails, or still more deeply under the soft parts of the fingers. In the latter case, swelling of the arm, inflammation of the lymphatics, and considerable constitutional disturbance, frequently attend. The complaint is always very painful, attended with great throbbing; and often terminating in the loss of the nail. We should, if possible, prevent suppuration, by the employment of local antiphlogistic means. If these do not succeed, a soft poultice may be used, and the collection should be opened as soon as possible.

Venesection. When a vein is to be opened in any part of the body, pressure must be made on the vessels, between the place where the puncture is to be made and the heart. This prevents the return of blood through the vessel, makes it swell, and become conspicuous. As the supply of blood is still continued through the arteries, the vein bleeds freely when it is opened; but care must be taken, particularly in the arm, and to apply the ligature so tightly as to stop the pulse. The bandage should be placed a little above the elbow, and the most prominent and conspicuous vein may be opened; excepting that, if equally convenient, one would avoid the vessel lying over the brachial artery. The vein may be fixed by placing the thumb of the left hand a little below the place where it is designed to introduce the lancet. That instrument should be pushed obliquely into the vein, and when its point is a little within the cavity, the opening may be rendered sufficiently large by carrying the front edge forward and upward, so as to bring it out of the part. In many cases, where we wish to make a sudden impression on the vascular system, we make the opening longer than usual, that the blood may be withdrawn more suddenly, and cause fainting. The stream may be accelerated, by putting the muscles of the fore-arm into action. It stops when the ligature is removed, or at least, if the surgeon press with his left thumb below the vein. The sides of the incision should be placed in contact, and maintained in that condition by a small compress of linen, bound on with the bleeding fillet applied in the form of the figure of eight. In opening the external jugular vein, the pressure must be made with the surgeon's finger; and the compress should be fastened by means of sticking plaster. The temporal artery may be opened by a simple puncture; and the bleeding may always be stopped by a compress fastened by means of sticking plaster. The operation of bleeding may be followed by various unpleasant consequences; as ecchymosis round the vein, inflammation of the integuments, absorbents, fascia, or vein itself. The former symptom generally disappears of itself in a week or ten days; the others may be treated according to the general principles of surgical practice.

PARTICULAR FRACTURES.

We shall say a few words on the most common and important kinds of fracture.

Fracture of the lower jaw may be detected by introducing a finger into the mouth and pressing on the front portion of the bone, while the fingers of the other hand are applied on the outside to the back of the bone. Alternate pressure in these situations occasions a very distinguishable crepitus. When the broken ends are adapted to each other, some wetted pasteboard is to be applied along the outer surface and base of the bone; and over this a bandage, with four tails, should be placed. The centre of this bandage is applied to the chin, the two posterior tails tied together at the top of the head, and the other two more posteriorly. The wet pasteboard adapts itself to the figure of the part, and constitutes, when dry, a splint exactly accommodated to the form

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of the jaw. All motion of the broken bone should be avoided: hence talking, chewing, &c. are improper; hence, too, the food should be soft, and introduced by a spoon.

The *fracture of the clavicle* is attended with a displacement of the bone; its scapular portion being drawn downwards and forwards. In order to restore it, let the shoulder be drawn backwards, and the arm raised; then the surgeon should place the fracture in as even a position as he can, cover it with a piece of soap plaster, and keep the shoulder back by means of the figure of eight bandage; the fore-arm and elbow being well supported by a string. A leather apparatus, lacing behind, and having straps to pass in front of the shoulders, similar to the instruments used for girls with the view of keeping the shoulders back, is a more effectual mode of accomplishing the object.

It is often difficult to detect *fracture of the ribs*. By placing the fingers where pain is felt, or where the blow was received, a crepitus can be distinguished in many cases, on making the patient cough; yet, if the matter be doubtful, the safest plan is to treat the patient as if his ribs were broken. It will be readily seen how emphysema, extravasation of blood, &c. may occur, when the bone is displaced inwardly. Our object is to keep the broken ends motionless. Hence, after a piece of soap plaster has been applied externally on the situation of the fracture, a broad roller should be put firmly round the chest, or we may apply an apparatus made expressly for the purpose, consisting of a broad girth, with three or four buckles and straps, which may be tightened at pleasure. Bleeding is proper, unless particular circumstances contraindicate it.

In *fractures of the os brachii*, after restoring the limb to its natural figure, and putting on a piece of soap plaster, apply a splint, lined with a pad of soft materials, from the acromion to the external condyle, and another from the margin of the axilla to the internal condyle. Some add two others, one before and one behind. They must all be carefully fastened with tapes, and the fore-arm and hand should be well supported by a sling. There is always a distinguishable crepitus in fractures of the fore-arm. After a piece of soap plaster has been applied, two splints must be employed; one is to be placed along the inside, and the other along the outside, of the fore arm. The limb is to be in the mid state, between pronation and supination; and the inner splint should reach far enough into the hand to support it, and prevent it from falling into the prone state.

In *fractures of the olecranon* the elbow must be placed straight, to approximate as much as possible the broken ends, and the limb must be continued in that position until the patient has recovered.

When the *os femoris* is broken, there is severe local pain, an incapacity to move the limb, a distinguishable crepitus on motion, and deformity of the part from retraction of the lower portion. The latter appearance will occur more readily, in proportion as the fracture is more oblique; and it arises entirely from the action of the muscles which are fixed in the bone below the fracture, together with the flexors of the knee. Besides the shortening of the limb, produced by the retraction of the lower portion of the fractured bone, there is another deformity, arising from its being rotated outwards, an effect produced by most of the large muscles of the thigh. The higher the fracture, the more difficult is it to prevent displacement. When the neck of the thigh bone is broken, there is severe pain in the groin, much aggravated by motion of the part. The extremity is shortened, the limb turned out, and the trochanter higher than usual towards the pelvis. Yet the limb may be drawn down to its natural length, in doing which a crepitus is sometimes perceived. In order to relax as much as possible the muscles which tend to displace the broken bone, a bent position of the thigh and leg was recommended by Mr. Pott. He recommended that the patient should lie on the side of the fracture, with the thigh bent on the pelvis, and the knee half bent. A broad splint, well padded, should be placed under the thigh, from above the trochanter to below the knee, and another should extend from the groin below the knee on the opposite surface. Narrower splints should occupy the intervals between those on the inside and outside of the thigh. The splints should be fastened as firmly as they can be borne, by means of leathern straps. A patient with a broken os femoris should by no means be placed on a soft bed, as the trunk of the body depresses it into a hollow, and by sliding downwards increases the displacement.

Fracture of the patella is generally caused by violent exertion of the muscles, whose tendons are inserted into this bone, and not by direct violence. The upper end of the bone is drawn upwards by the

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muscles, and total inability to extend the leg is generally observed. The muscles should be relaxed, by extending the knee, and bending the thigh on the pelvis: they may also be surrounded with a roller, a compress being placed just above the upper portion of the broken bone. The newly-formed substance which unites the broken ends is of a ligamentous or cartilaginous nature, and not bony.

Fractures of the leg. If they affect both bones, there can be no doubt of the nature of the case; but the symptoms are more uncertain, when the fibula alone is broken. The limb should be laid on its outside, with the knee moderately bent. Japanned iron, or wooden splints shaped to the part, and covered with soft pads, are employed. The leg having been placed in the above mentioned position, extension is made, if necessary; and the under splint, covered with its pad, and having an eighteen-tailed bandage laid on it, is passed under the limb. Having observed that the ends of the bones are in exact contact, the surgeon places his soap plaster over the fractured portion, and lays down the bandage. Another soft pad is then put over the upper surface of the leg, and the other splint applied. The leather straps attached to the splints are fastened with sufficient tightness, to prevent any motion of the fractured part. When the pressure of the splints is painful, soft pads are necessary.

Ruptured tendo Achillis. The large tendon of the muscles of the calf of the leg is sometimes torn asunder by the violent exertion of those muscles. An inability to extend the ankle, and a consequent impaired power of progression, follows. The ends of the tendon may be approximated by straightening the ankle and bending the knee. The foot may be kept in this position by the assistance of bandages. The case requires about the same degree of confinement as a fracture. Some persons have not kept their bed for this accident, but have walked about with a high-heeled shoe. The tendon of the plantaris muscle is sometimes ruptured, and the accident is attended with the symptoms as if the tendo Achillis were torn.

END OF VOL. XI.

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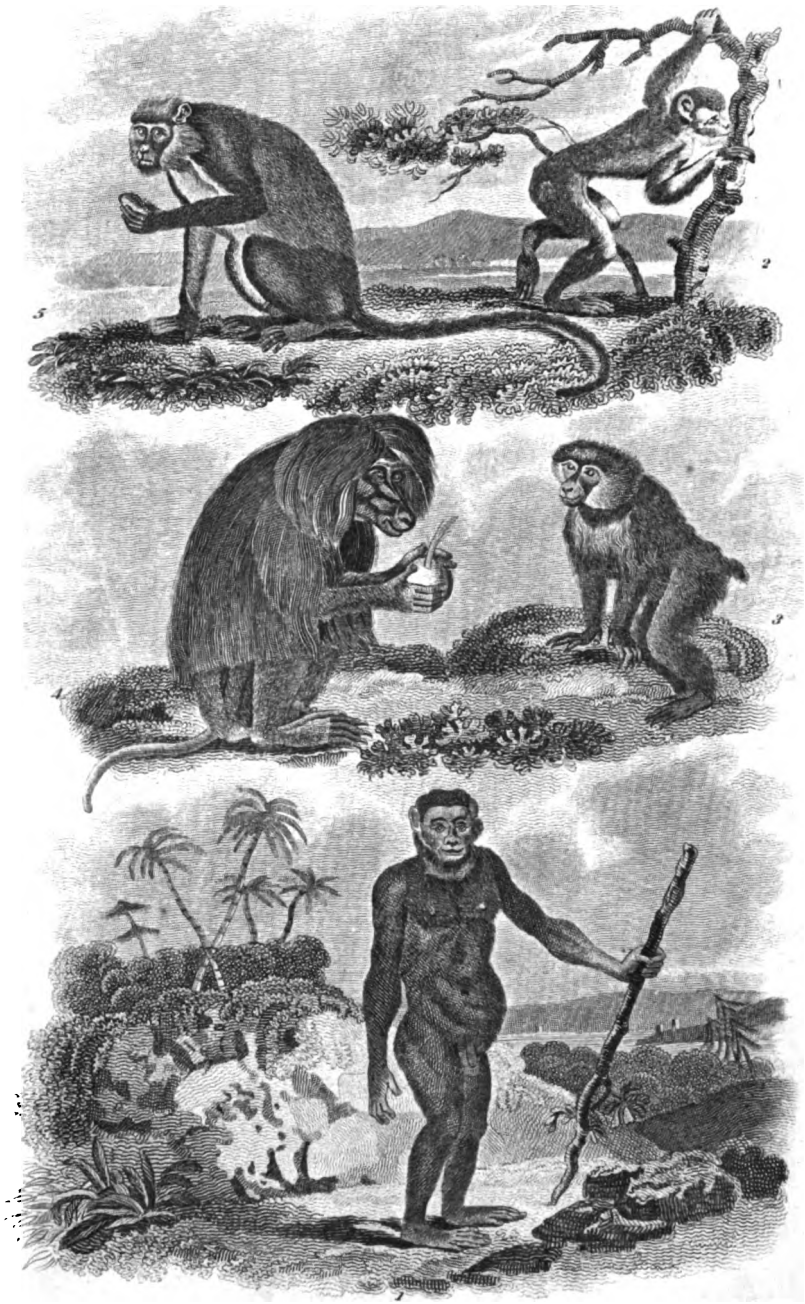

Fig. 1. Simia satyrus: Orang-outang. Fig. 2. S. inus: Barbary ape. Fig. 3. S. sphynx: Great baboon Fig. 4. S. lamina: lemine monkey. Fig. 5. S. mona: varied monkey.

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Fig.1. Sorex *minutus: minute shrew. Fig.2.S. radiatus: radiated shrew. Fig.3.S.moschatus: musky shrew: Fig.4.* Sorex *vulgaris: Fig.5 & 6.* Talpa *Europæa: common mole & radiated mole.*

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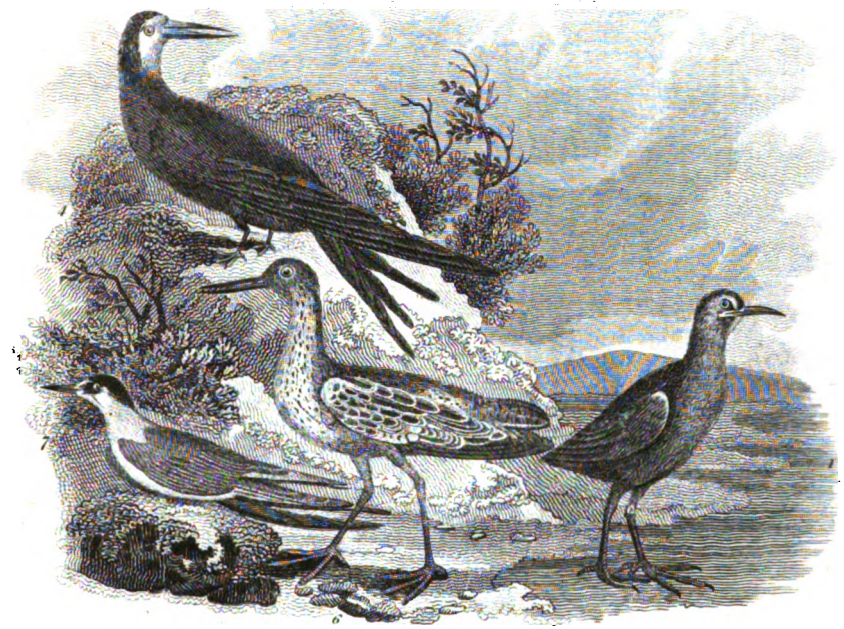

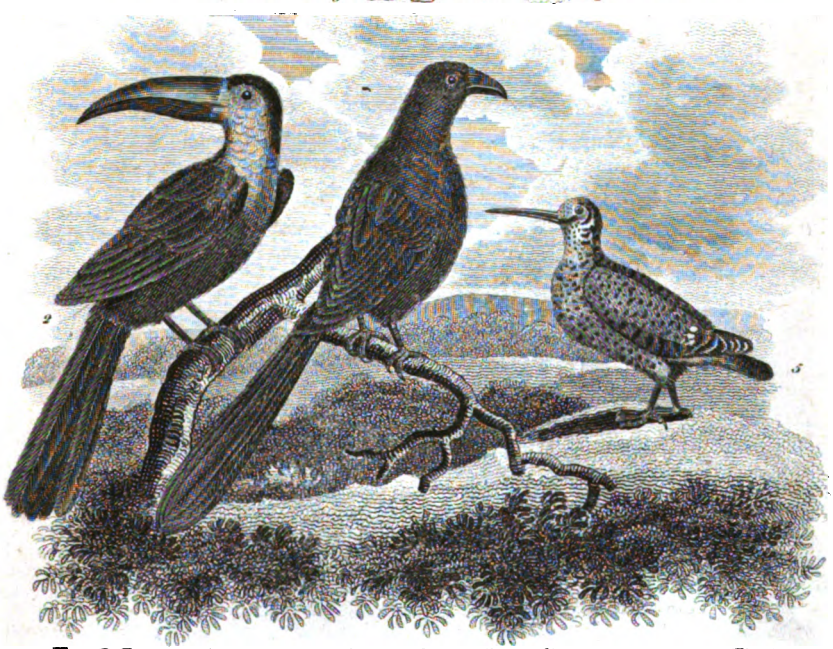

Fig. 1. Rallus aquaticus: *Water rail.* *Fig. 2.* Ramphastos dicolorus: *Yellow throated toucan.* *Fig. 3.* Rynchops nigra: *Skimmer.* *Fig. 4.* Recurvirostra avocetta: *Scooping avocet.* *Fig. 5.* Scolopax rusticola: *Woodcock.* *Fig. 6.* S. calidris: *redshank.* *Fig. 7.* Sterna minuta: *Lesser tern.*

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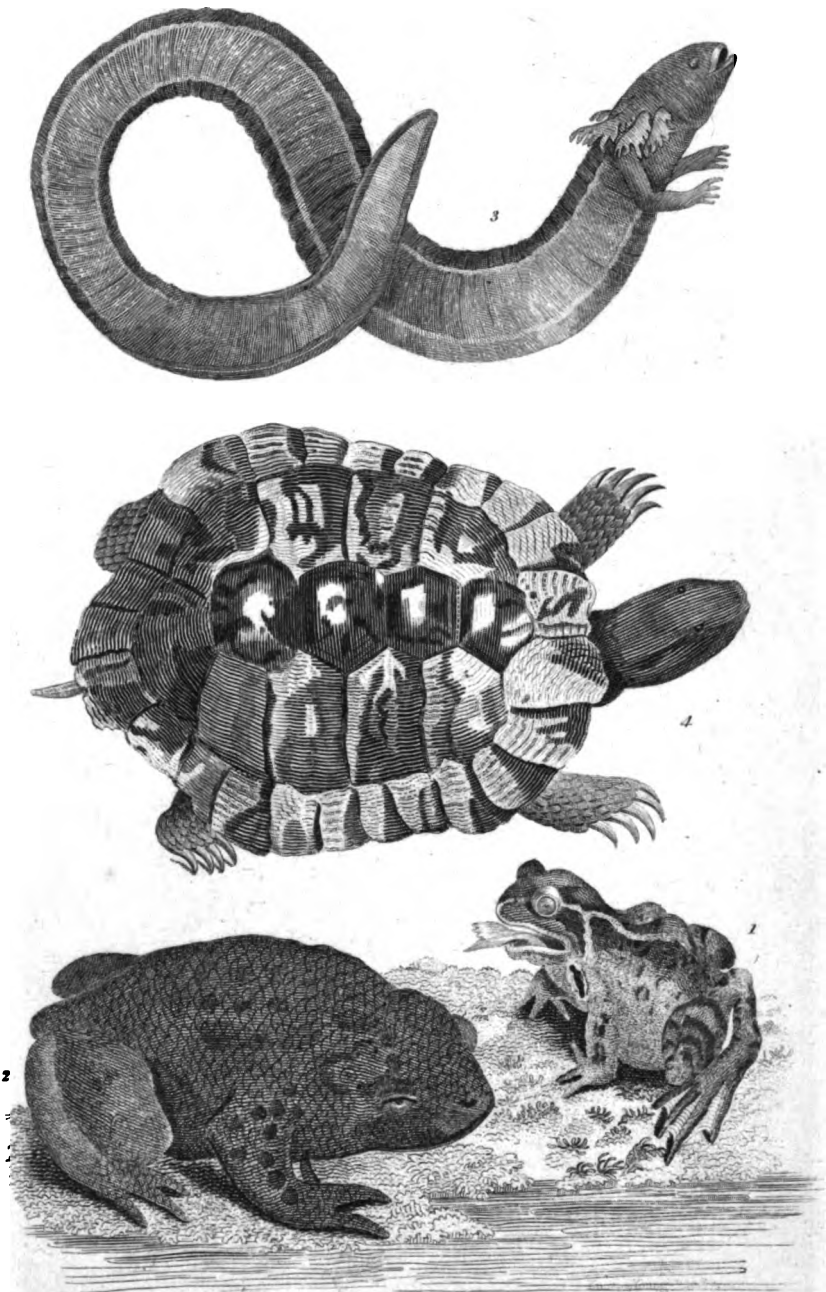

Fig. 1. Rana *temporaria common Frog. Fig. 2.* R. *bufo: common toad. Fig. 3.* Siren *lacertina: eel-shaped Siren. Fig. 4.* Testudo *Graeca: common Tortoise.*

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SHORT-HAND.

The Alphabet.

Invented by John Byrom, M. A. & F. R. S.

		Words.	Prepositions.	Terminations.
B		Be. but	Be-	-ble or -able
d		And	De- dis-	-ed.
v		Of	.....	-ify
g		Again / Against	.....	.....
h		Have. had	.....	.....
j		Judge. just	.....	.....
k		Can / Could	Com- or con- / Contra	-ical
l		All. always. altogether	.....	.....
m		Am / Amongst	Magni- / Mis- / Omni-	-ment -ments
n		In / In / Under	Inte- or anti- / In- or inter- / Un- or under-	-ence / -ent / -ness
p		Upon	Per- pre- or pro-	.....
q		Question	.....	.....
r		Or	Re-	-ary -ring -rings
s or z		As / Is / Ms	Satis- / Circum- / Sub- or super-	-ation / -ation / -ation / -ation / -self / -soever
t		The	Trans-	-ity -ities
w		Will. would	With-	-ward -wards
x		Except - exercise -	Ex- extra -	.....
y		Yet	.....	.....
ch		Which	.....	.....
sh		Shall. should	.....	-ship -ships
th		That	.....	.....
&c		&c.	.....	.....

Vowels' Places.

as. es. &c. sa. se. &c. al. el. &c. ka. ke. &c.

am. em. &c. ma. me. &c. an. en. &c. na. ne. &c.

Figures.

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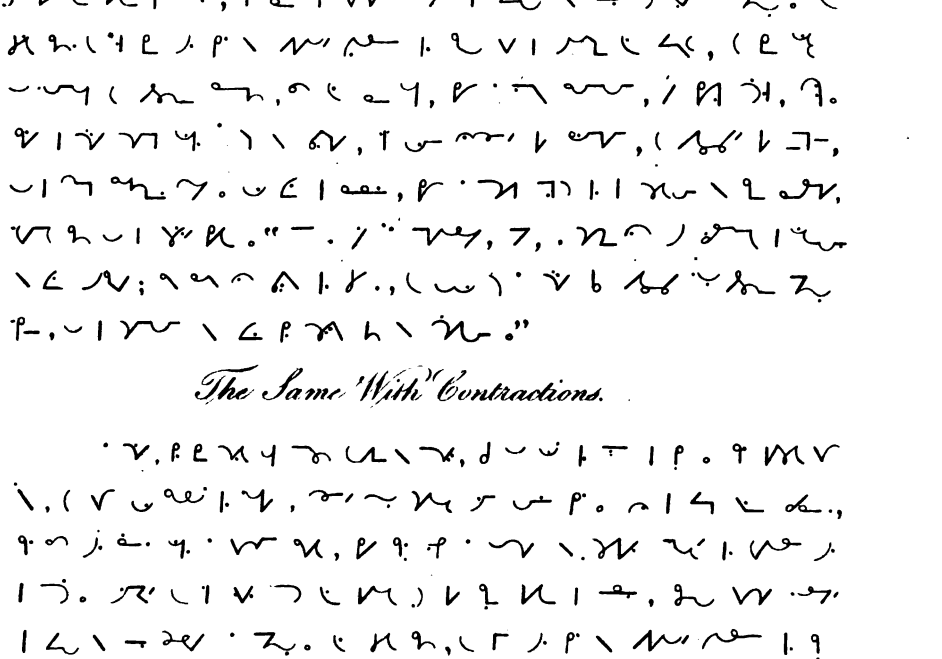
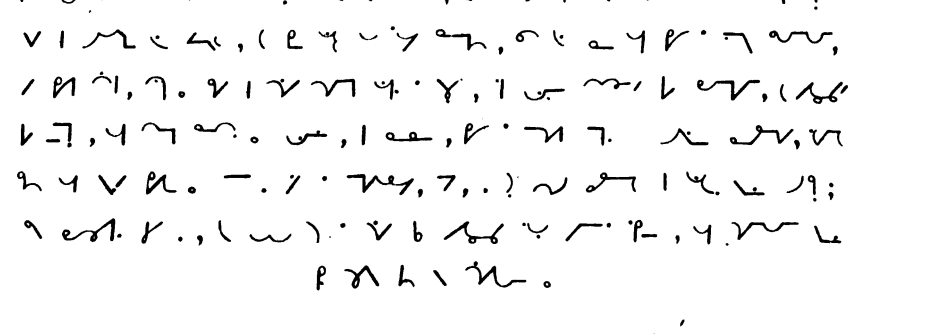
SHORT-HAND.

Specimens.

The Bear. A Fable.



The Same With Contractions.



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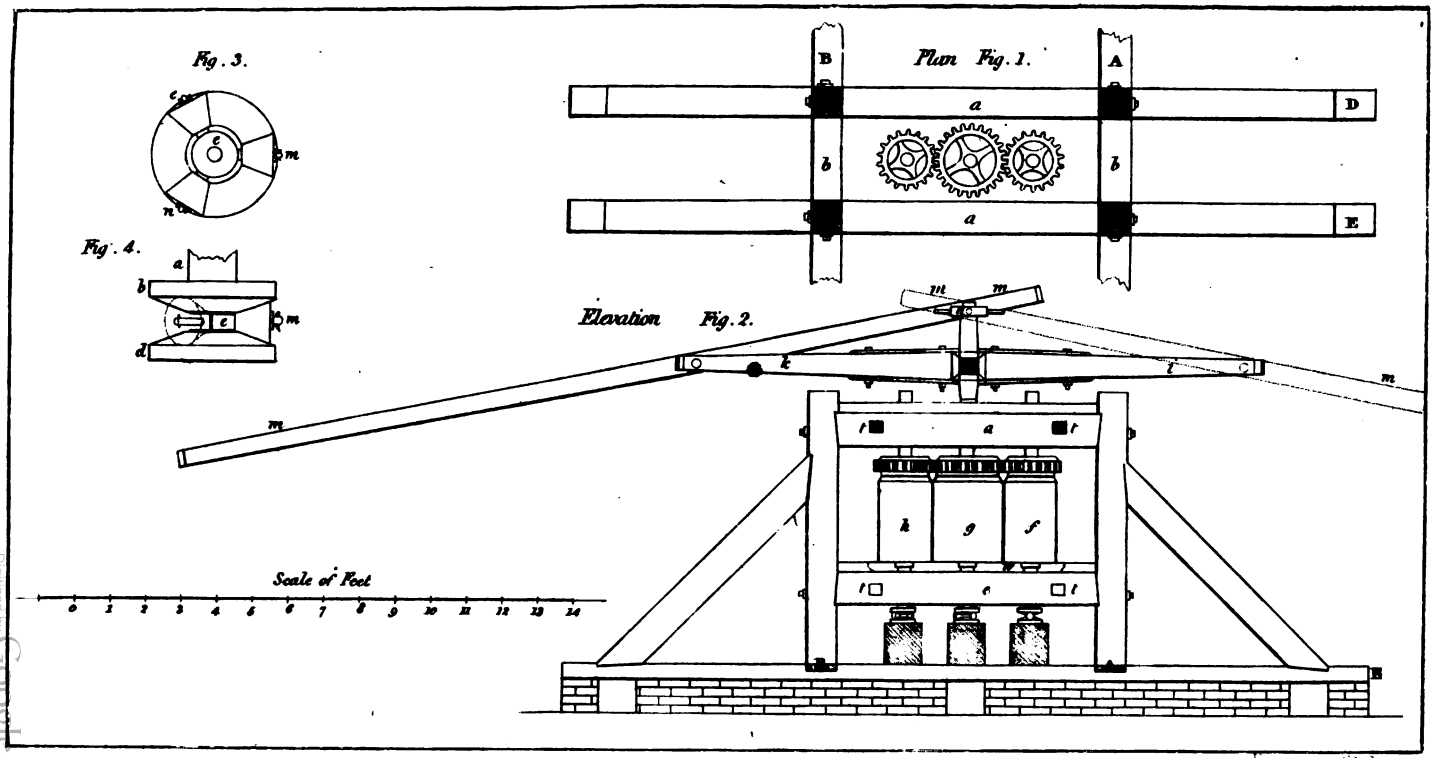
SUGAR MILL by Mr. Thos. ROWNTREE.



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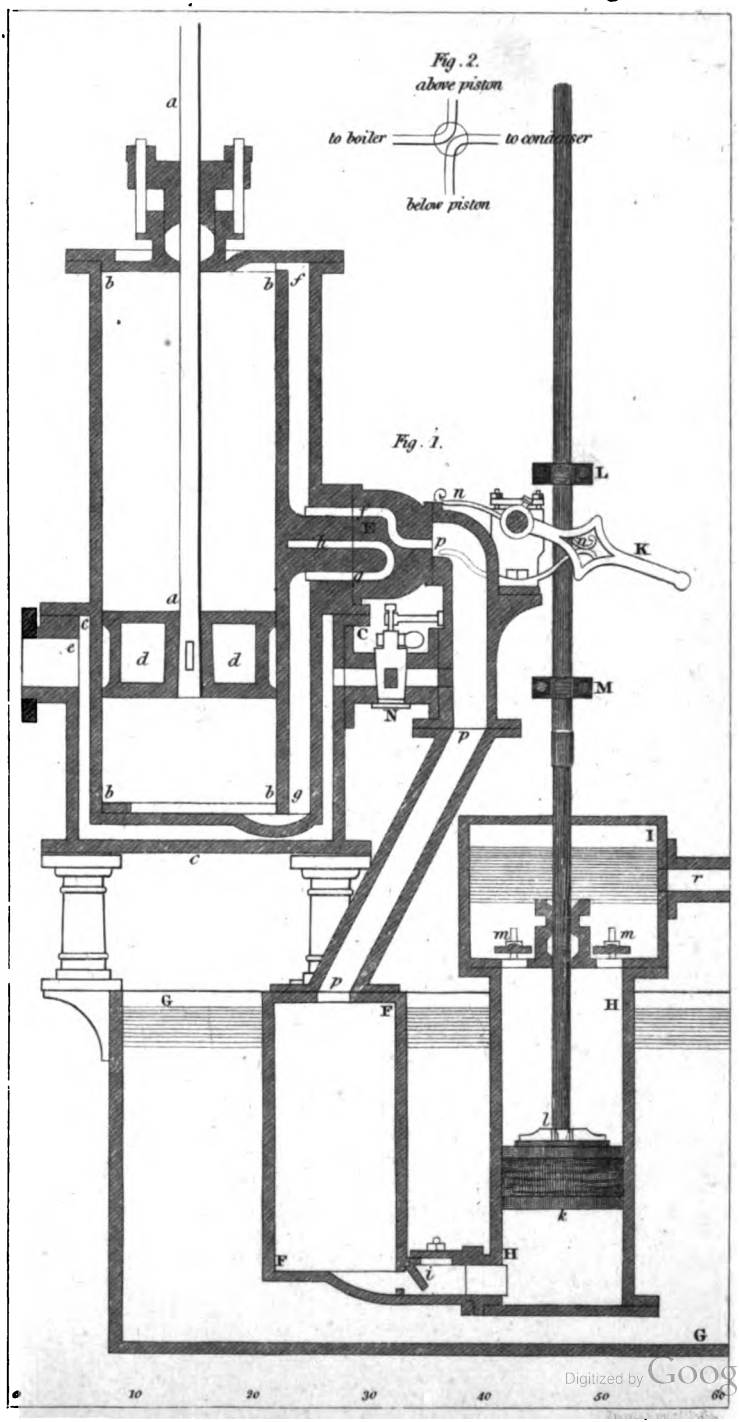
Section of Cylinder and pipes of Dixons Steam Engine.



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SAW MILL.

Fig. 1.

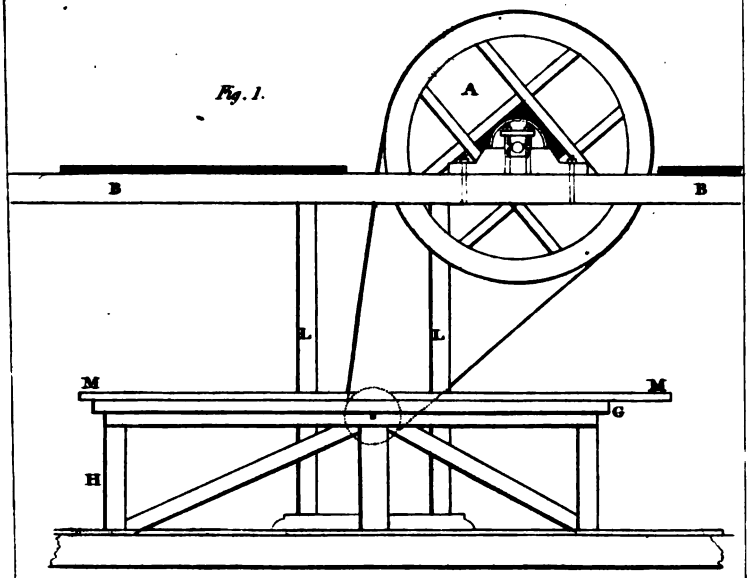


Fig. 2.

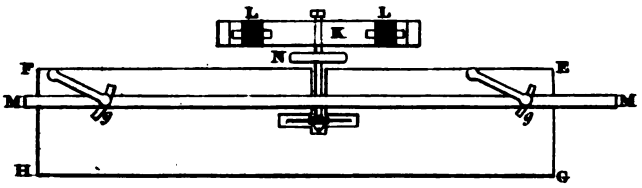


Fig. 3.

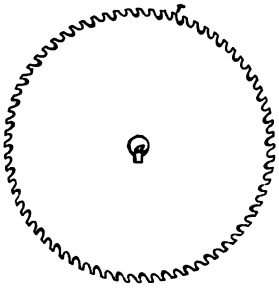
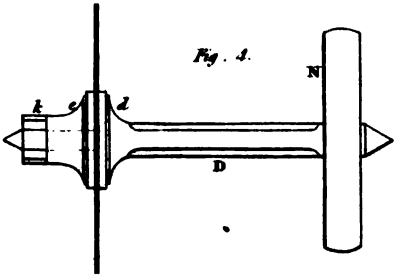


Fig. 4.



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Hawkins's Scotograph,
or machine for writing in the dark.

Fig. 1.

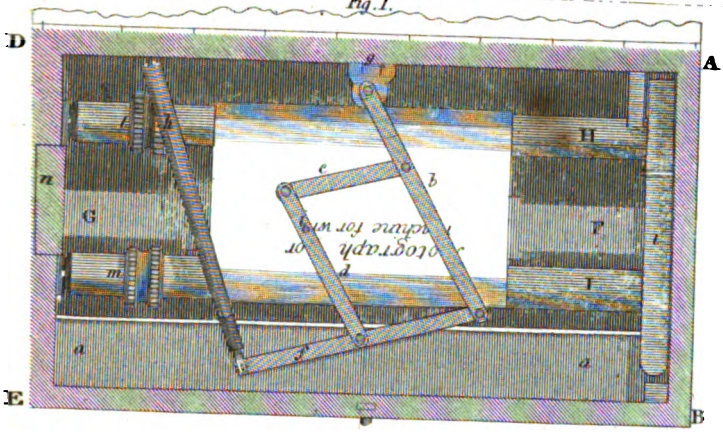


Fig. 2.

Fig. 3.

Fig. 4.

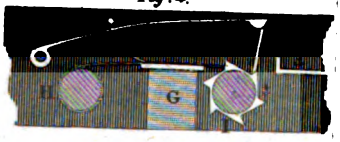
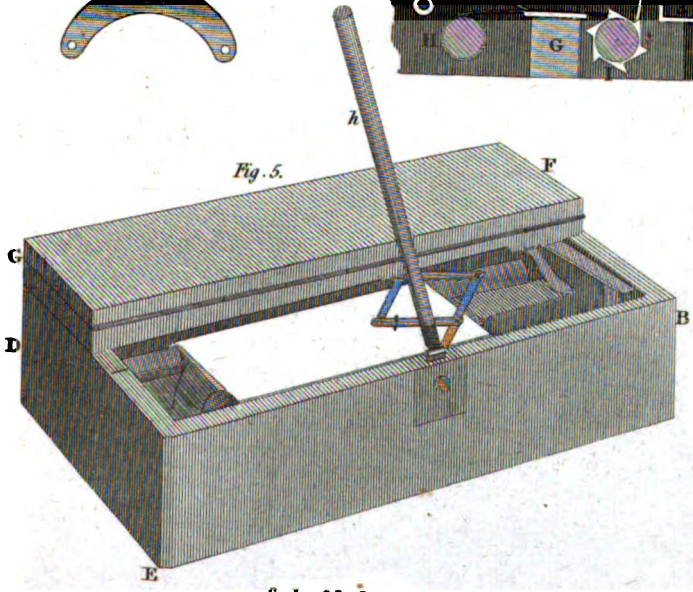


Fig. 5.



Scale of Inches.

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